

# STS-95

## SPACE SHUTTLE PRESSKIT



## STS-95

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# STS-95

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## Mission Overview

### STS-95 SCIENCE SPANS INNER UNIVERSE TO OUTER SPACE

More than thirty six years after he made history as the first American to orbit the Earth, Senator John H. Glenn, Jr. will return to space as part of a multi-national crew with the launch of Space Shuttle Discovery in late October. The flight, designated STS-95, will involve more than eighty scientific experiments investigating mysteries that span the realm from the inner universe of the human body to studies of our own Sun and its solar activity

Back on February 20, 1962, when Glenn flew in his Friendship 7 Mercury capsule, the largest mystery facing the young NASA space program was whether humans could even survive in the hostile environment of space. In the 121 space missions since Glenn's flight during the Mercury, Gemini, Apollo, Skylab and Shuttle programs, more than 200 Americans have flown – and thrived – in space. Glenn, who inspired many current astronauts to pursue space flight as a career, continues to inspire people of all generations as he prepares for a return to space.

The wealth of scientific data accumulated during these space flights validate apparent similarities between the effects of space flight and aging. Glenn will be a test subject for specific investigations which mimic the effect of aging, including loss of muscle mass and bone density; disrupted sleep patterns; a depressed immune system; and loss of balance.

Scientific endeavors on the STS-95 mission are not limited to furthering an understanding of the human body, but also will expand our understanding of the closest star to our planet, the Sun, and how it affects life on Earth. The Spartan 201 spacecraft will be released by the crew on the fourth day of the mission and will spend two days flying free studying heating of the solar corona and the acceleration of the solar wind that originates in the corona and how that phenomenon affects activities both in Earth-orbit and on the ground. The Sun drives our weather, and energetic eruptions on the Sun are capable of disrupting satellites, communication and power systems. The Sun also establishes the space environment in which our communications, weather, defense and human spaceflight resources operate. Upon completion of two days of solar observations, Discovery's crew will haul the spacecraft back into the Shuttle's cargo bay and return it to Earth.

Six astronomical instruments comprise the International Extreme Ultraviolet Hitchhiker Experiment (IEH-3) which will be carried in Discovery's payload bay. These six diverse instruments support a range of experiments

including studies of stars, remnants of supernovae, and star formation. Also tucked in the payload bay is a variety of materials and equipment destined for use during the third Hubble Space Telescope servicing mission, currently scheduled for a mid-2000 launch. Referred to as HOST, the Hubble Space Telescope Optical Systems Test payload, will demonstrate that actual electronic and thermo-dynamic equipment scheduled for installation into the Telescope performs acceptably in the radiation and zero gravity environment of space.

Discovery also will carry a Spacehab module to orbit. Inside Spacehab, almost 30 smaller experiments ranging from materials science, to plant growth, to developing new techniques for delivering vital anti-tumor medications, will be conducted by the astronauts. Sponsored by NASA, the Canadian Space Agency, the European Space Agency, and the Japanese Space Agency NASDA, these studies take the best advantage of the unique environment of space to conduct these diverse studies.

The STS-95 mission will be led by 42 year old Curtis L. Brown, Jr. (Lt. Col., USAF), making his fifth space flight. Serving as Pilot will be Steven W. Lindsey (Lt. Col., USAF), 38, making his second flight. There are three astronauts serving as STS-95 mission specialists. Making his second flight is Mission Specialist-1 Stephen K. Robinson (Ph.D.), who is also the STS-95 Payload Commander and who will turn 43 a few days before launch. Serving as the Flight Engineer and Mission Specialist-2 is Dr. Scott E. Parazynski (M.D.), 37, making his third flight. European Space Agency (ESA) astronaut Pedro Duque, 35, is Mission Specialist-3 and is making his first space flight. The two STS-95 payload specialists, 46 year old Dr. Chiaki Mukai (M.D., Ph.D.) from the Japanese Space Agency (NASDA) and Senator John H. Glenn, Jr. (Col., USMC, Ret.), 77, are both making their second space flight.

Discovery is set for launch on October 29 1998, from NASAs Kennedy Space Center Launch Complex 39-B. The launch time is targeted for 2:00 p.m. EST at the opening of the available 2 ½ hour launch window. The STS-95 mission is scheduled to last 8 days, 22 hours, 4 minutes. An on-time launch on October 29 and nominal mission duration would have Discovery landing back at Kennedy Space Center at the end of a more than 3 ½ million mile journey on November 7 just after 12 noon Eastern.

STS-95 will be the 25th flight of Discovery and the 92nd mission flown since the start of the Space Shuttle program in April 1981.

# STS-95

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## Discovery OV103

Launch: Thursday, October 29, 1998  
2:00 PM (eastern time)

### Mission Objectives

The primary mission objectives are to successfully perform the planned operations of the four primary payloads: SPACEHAB, HOST, IEH-03, and SPARTAN-201.

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### Crew

<b>Commander:</b>	Curtis L. Brown
<b>Pilot:</b>	Steven W. Lindsey
<b>Mission Specialist 1:</b>	Stephen K. Robinson
<b>Mission Specialist 2:</b>	Scott E. Parazynski
<b>Mission Specialist 3:</b>	Pedro Duque
<b>Payload Specialist 1:</b>	Chiaki Mukai
<b>Payload Specialist 2:</b>	John H. Glenn

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### Launch

<b>Orbiter</b>	Discovery OV103
<b>Launch Site:</b>	Pad 39-B Kennedy Space Center
<b>Launch Window:</b>	2 hours, 30 minutes
<b>Altitude:</b>	300 nautical miles
<b>Inclination:</b>	28.45 degrees
<b>Duration:</b>	8 Days 21 Hrs. 50 Min.
<b>Shuttle Liftoff Weight:</b>	4,521,918 lbs.
<b>Software Version:</b>	OI-26B

## **Space Shuttle Main Engine**

**SSME 1:** #2048

**SSME 2:** #2043

**SSME 3:** #2045

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## **Landing**

**Landing Date:** 11/07/98  
**Landing Time:** 11:50 AM (eastern time)  
**Primary Landing Site:** Shuttle Landing Facility, KSC  
**Orbiter/Payload Weight at Landing:** 227,783 lbs.

### **Abort Landing Sites:**

**RTLS:** Shuttle Landing Facility, KSC  
**TAL:** Banjul, The Gambia; Ben Guerir, Morocco; Moron, Spain  
**AOA:** Edwards Air Force Base, California

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## **Payloads**

### **Cargo Bay**

SPACEHAB  
SPARTAN 201-5  
HST Orbital Systems Test Platform (HOST)  
International Extreme Ultraviolet Hitchhiker (IEH-3)  
Cryogenic Thermal Storage Unit (CRYOTSU)  
SPACE EXPERIMENT MODULE 4  
Getaway Special Program

### **In-Cabin**

Biological Research in Canisters (BRIC)  
ELECTRONIC NOSE (E-NOSE)

Updated: 10/08/1998

# STS-95

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## Crew Profile Menu

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### **Commander:** Curtis L. Brown

As commander, Brown is ultimately responsible for mission safety and success.

PRIME DUTIES: Protein Crystal Growth, Rendezvous, Spacehab Science  
STS-47, September 12-20, 1992 STS-66, November 3-14, 1994  
STS-77, May 19-29, 1996 STS-85, August 7-19, 1997

**Ascent Seating:** Flight Deck - Port Forward  
**Entry Seating:** Flight Deck - Port Forward

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### **Pilot:** Steven W. Lindsey

PRIME DUTIES: IVA Crew, Spacehab Science

BACKUP DUTIES: Protein Crystal Growth, Rendezvous, Rendezvous Tools  
STS-87, November 19-December 5, 1997

**Ascent Seating:** Flight Deck - Starboard Forward  
**Entry Seating:** Flight Deck - Starboard Forward  
IV1

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### **Mission Specialist 1:** Stephen K. Robinson

PRIME DUTIES: IEH, Spacehab Systems, Robotic Experiments, Remote Manipulator System, Payload Bay Door Closing, Rendezvous Tools, Payload Commander

STS-85, August 7-19, 1997

**Ascent Seating:** Mid Deck - Port  
**Entry Seating:** Flight Deck - Starboard Aft  
EV1

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## **Mission Specialist 2:** Scott E. Parazynski

**PRIME DUTIES:** SPARTAN, HOST, Payload Bay Door Opening, Rendezvous Tools

**BACKUP DUTIES:** IEH, Robotic Experiments, Remote Manipulator System, Payload Bay Door Closing  
STS-66, November 3-14, 1994 STS-86, September 25-October 6, 1997

**Ascent Seating:** Flight Deck - Center Aft

**Entry Seating:** Flight Deck - Center Aft



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## **Mission Specialist 3:** Pedro Duque

**PRIME DUTIES:** Spacehab Science

**BACKUP DUTIES:** Spacehab Systems, Payload Bay Door Opening  
None

**Ascent Seating:** Flight Deck - Starboard Aft

**Entry Seating:** Mid Deck - Port

**EV2**



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## **Payload Specialist 1:** Chiaki Mukai

**PRIMARY DUTIES:** Spacehab Science

STS-65, July 8-23, 1994

**Ascent Seating:** Mid Deck - Starboard

**Entry Seating:** Mid Deck - Starboard



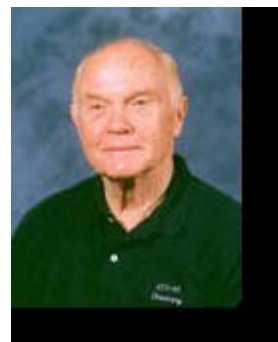
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## **Payload Specialist 2:** John H. Glenn

**PRIME DUTIES:** Spacehab Science  
Friendship 7, February 20, 1962

**Ascent Seating:** Mid Deck - Center

**Entry Seating:** Mid Deck - Center





## Crew Profile

Curtis L. Brown



**NAME:** Curtis L. Brown, Jr. (Lieutenant Colonel, USAF)  
NASA Astronaut

**PERSONAL DATA:**

Born March 11, 1956, in Elizabethtown, North Carolina. Unmarried. One son. He enjoys water and snow skiing, scuba diving, air racing, restoring old cars, sailing, aerobatic flying. His mother, Mrs. Rachel H. Brown, resides in Elizabethtown, North Carolina. His father, Mr. Curtis L. Brown, Sr., is deceased.

**EDUCATION:**

Graduated from East Bladen High School, Elizabethtown, North Carolina, in 1974; received a bachelor of science degree in electrical engineering from the Air Force Academy in 1978.

**ORGANIZATIONS:**

Member, United States Air Force Association, United States Air Force Academy Association of Graduates, Experimental Aircraft Association and Classic Jet Aircraft Association.

**SPECIAL HONORS:**

Defense Superior Service Medal, Defense Meritorious Service Medal (2), Air Force Meritorious Service Medal, Air Force Commendation Medal, Air Force Achievement Medal, NASA Space Flight Medal (4).

**EXPERIENCE:**

Brown was commissioned a second lieutenant at the United States Air Force Academy, Colorado Springs, in 1978, and completed undergraduate pilot training at Laughlin Air Force Base, Del Rio, Texas. He graduated in July 1979 and was assigned to fly A-10 aircraft at Myrtle Beach Air Force Base, South Carolina, arriving there in January 1980 after completing A-10 training at Davis-Monthan Air Force Base, Arizona. In March 1982, he was reassigned to Davis-Monthan Air Force Base as an instructor pilot in the A-10. In January 1983, he attended USAF Fighter Weapons School at Nellis Air Force Base and returned to Davis-Monthan Air Force Base as an instructor in A-10 weapons and tactics. In June 1985, he attended USAF Test Pilot School at Edwards Air Force Base, California. Upon graduation in June 1986, Brown was assigned to Eglin Air Force Base, Florida, where he served as a test pilot in the A-10 and F-16 aircraft until his selection for the astronaut program. He has logged over 6,000 hours flight time in jet aircraft.

**NASA EXPERIENCE:**

Selected as an astronaut candidate by NASA in June 1987, Brown completed a one-year training and evaluation program in August 1988, and is qualified for flight assignment as a pilot. His technical assignments have included: involvement in the upgrade of the Shuttle Mission Simulator (SMS); development of the Flight Data File (FDF); he served as lead of the astronaut launch support team responsible for crew ingress/strap-in prior to launch and crew egress after landing; monitored the refurbishment of OV-102 and OV-103 during ground turnaround processing; lead spacecraft communicator (CAPCOM); Astronaut Office Lead of Shuttle Operations. A veteran of four space flights, Brown has logged over 977 hours in space. He was the pilot on STS-47 in 1992, STS-66 in 1994 and STS-77 in 1996, and was spacecraft commander on STS-85 in 1997. Brown is assigned to command the crew of STS-95. This mission will support a variety of research payloads including deployment of the Spartan solar-observing spacecraft, the Hubble Space Telescope Orbital Systems Test Platform, and investigations on space flight and the aging process. STS-95 is scheduled for launch in October 1998.

**SPACE FLIGHT EXPERIENCE:**

STS-47 Spacelab-J (September 12-20, 1992) was an eight-day cooperative mission between the United States and Japan focused on life science and materials processing experiments in space. After completing 126 orbits of the Earth, the mission ended with Space Shuttle Endeavour landing at Kennedy Space Center, Florida. Mission duration was 190 hours, 30 minutes, 23 seconds.

STS-66 (November 3-14, 1994) was the Atmospheric Laboratory for Applications and Science-3 (ATLAS-3) mission. ATLAS-3 was part of an ongoing program to determine the Earth's energy balance and atmospheric change over an 11-year solar cycle. Following 175 orbits of the Earth, the 11-day mission ended with the Shuttle Atlantis landing at Edwards Air Force Base, California. Mission duration was 262 hours and 34 minutes.

STS-77 (May 19-29, 1996) was a ten-day mission aboard Space Shuttle Endeavour. The crew performed a record number of rendezvous sequences (one with a SPARTAN satellite and three with a deployed Satellite Test Unit) and approximately 21 hours of formation flying in close proximity of the satellites. During the flight the crew also conducted 12 materials processing, fluid physics and biotechnology experiments in a Spacehab Module. STS-77 deployed and retrieved a SPARTAN satellite, which carried the Inflatable Antenna Experiment designed to test the concept of large, inflatable space structures. A small Satellite Test Unit was also deployed to test the concept of self-stabilization by using aerodynamic forces and magnetic damping. The mission was concluded in 160 Earth orbits, traveling 4.1 million miles in 240 hours and 39 minutes.

STS-85 (August 7-19, 1997) was a 12-day mission during which the crew deployed and retrieved the CRISTA-SPAS payload, operated the Japanese Manipulator Flight Demonstration (MFD) robotic arm, studied changes in the Earth's atmosphere and tested technology destined for use on the

future International Space Station. The mission was accomplished in 189 Earth orbits, traveling 4.7 million miles in 284 hours and 27 minutes.

APRIL 1998

Updated: 10/07/1998

## Crew Profile

Steven W. Lindsey



**NAME:** Steven W. Lindsey (Lieutenant Colonel, USAF)  
NASA Astronaut

**PERSONAL DATA:**

Born August 24, 1960, in Arcadia, California. Considers Temple City, California, to be his hometown. Married to the former Diane Renee Trujillo. They have three children. He enjoys reading, water and snow skiing, scuba diving, windsurfing, camping, running, and racket sports. His parents, Arden and Lois Lindsey, reside in Arcadia, California. Her parents, Gene and Marcene Trujillo, reside in Temple City, California.

**EDUCATION:**

Graduated from Temple City High School, Temple City, California, in 1978; received a bachelor of science degree in engineering sciences from the U.S. Air Force Academy in 1982, and a master of science degree in aeronautical engineering from the Air Force Institute of Technology in 1990.

**ORGANIZATIONS:**

Member, Society of Experimental Test Pilots, USAF Academy Association of Graduates.

**SPECIAL HONORS:**

Distinguished Graduate Air Force Undergraduate Pilot Training (1983). Distinguished Graduate and recipient of the Liethen-Tittle Award as the outstanding test pilot of the USAF Test Pilot School Class 89A (1989). Awarded Air Force Meritorious Service Medal, Air Force Commendation Medal, Air Force Achievement Medal and Aerial Achievement Medal.

**EXPERIENCE:**

Lindsey was commissioned a second lieutenant at the United States Air Force Academy, Colorado Springs, Colorado, in 1982. In 1983, after receiving his pilot wings at Reese Air Force Base, Texas, he qualified in the RF-4C Phantom II and was assigned to the 12th Tactical Reconnaissance Squadron at Bergstrom Air Force Base, Texas. From 1984 until 1987, he served as a combat-ready pilot, instructor pilot, and academic instructor at Bergstrom. In 1987, he was selected to attend graduate school at the Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio, where he studied aeronautical engineering. In 1989, he attended the USAF Test Pilot School at Edwards Air Force Base, California. In 1990, Lindsey

was assigned to Eglin Air Force Base, Florida, where he conducted weapons and systems tests in F-16 and F-4 aircraft. While a member of the 3247th Test Squadron, Lindsey served as the deputy director, Advanced Tactical Air Reconnaissance System Joint Test Force and as the squadron's F-16 Flight Commander. In August of 1993 Lindsey was selected to attend Air Command and Staff College at Maxwell Air Force Base, Alabama. Upon graduation in June of 1994 he was reassigned to Eglin Air Force Base, Florida as an Integrated Product Team leader in the USAF SEEK EAGLE Office where he was responsible for Air Force weapons certification for the F-16, F-111, A-10, and F-117 aircraft. In March of 1995 he was assigned to NASA as an astronaut candidate. He has logged over 3300 hours of flying time in 50 different types of aircraft.

#### **NASA EXPERIENCE:**

Selected by NASA in December 1994, Lindsey became an astronaut in May 1996, qualified for flight assignment as a pilot. Initially assigned to flight software verification in the Shuttle Avionics Integration Laboratory (SAIL), Lindsey also served as the Astronaut Office representative working on the Multifunction Electronic Display System (MEDS) program, a glass cockpit Space Shuttle upgrade program, as well as a number of other advanced upgrade projects. He flew on STS-87 in 1997 and has logged over 376 hours in space. He will serve as pilot on the crew of STS-95, supporting a variety of research payloads including deployment of the Spartan solar-observing spacecraft, the Hubble Space Telescope Orbital Systems Test Platform, and investigations on space flight and the aging process. STS-95 is scheduled for launch in October 1998.

#### **SPACE FLIGHT EXPERIENCE:**

STS-87 (November 19 to December 5, 1997) was the fourth U.S Microgravity Payload flight and focused on experiments designed to study how the weightless environment of space affects various physical processes, and on observations of the Sun's outer atmospheric layers. Two members of the crew performed an EVA (spacewalk) which featured the manual capture of a Spartan satellite, and tested EVA tools and procedures for future Space Station assembly. During the EVA, Lindsey piloted the first flight of the AERCam Sprint, a free-flying robotic camera. The mission was accomplished in 252 orbits of the Earth, traveling 6.5 million miles in 376 hours and 34 minutes.

FEBRUARY 1998

## Crew Profile

Stephen K. Robinson



**NAME:** Stephen K. Robinson (Ph.D.)  
NASA Astronaut

**PERSONAL DATA:**

Born October 26, 1955, in Sacramento, California. Unmarried. Enjoys flying, antique aircraft, swimming, canoeing, hiking, music, art, computer graphics and stereo photography. His parents, William and Joyce Robinson, reside in Moraga, California.

**EDUCATION:**

Graduated from Campolindo High School, Moraga, California, 1973; Bachelor of Science degree in mechanical/aeronautical engineering from University of California at Davis, 1978; Master of Science degree in mechanical engineering from Stanford University, 1985; Doctorate in mechanical engineering, with a minor in aeronautics and astronautics from Stanford University, 1990.

**ORGANIZATIONS:**

American Institute of Aeronautics and Astronautics, Aerospace Medical Association, Aircraft Owners and Pilots Association, Experimental Aircraft Association.

**SPECIAL HONORS:**

NASA Ames Honor Award for Scientist (1989); American Institute of Aeronautics and Astronautics Outstanding Technical Paper Award for Applied Aerodynamics (co-author) (1992); NASA/Space Club G.M. Low Memorial Engineering Fellowship (1993).

**EXPERIENCE:**

Robinson started work for NASA in 1975 as a student co-op at NASA's Ames Research Center in Mountain View, California. After graduation from University of California at Davis, he joined NASA Ames as a research scientist in the fields of fluid dynamics, aerodynamics, experimental instrumentation, and computational scientific visualization. While at Ames, Robinson earned masters and doctorate degrees in mechanical engineering at Stanford University, with research emphasis in turbulence physics, and additional research in human eye dynamics. In 1990, Robinson was selected as Chief of the Experimental Flow Physics Branch at NASA's Langley Research Center in Hampton, Virginia, with responsibility for 8 wind tunnels and an engineering staff engaged in

aerodynamics and fluids research. In 1993, Robinson was awarded the NASA/Space Club G.M. Low Memorial Engineering Fellowship, and was assigned for 15-months to the Massachusetts Institute of Technology (MIT) as Visiting Engineer in the Man Vehicle Laboratory (MVL). As an MVL team-member, he conducted neurovestibular research on astronauts on the Spacelab Life Sciences 2 Shuttle mission (STS-58). Other MIT research included EVA dynamics for satellite capture and space construction. While in Cambridge, Massachusetts, Robinson was also a visiting scientist at the U.S. Department of Transportation's Volpe National Transportation Systems Center, doing research on environmental modeling for flight simulation, cockpit human factors for GPS-guided instrument approach procedures, and moving-map displays. Robinson returned to NASA Langley in September 1994, where he accepted a dual assignment as research scientist in the Multidisciplinary Design Optimization Branch, and as leader of the Aerodynamics and Acoustics element of NASA's General Aviation Technology program. Robinson has over 1000 hours in aircraft ranging from antique taildraggers to NASA jets.

#### **NASA EXPERIENCE:**

Selected by NASA in December 1994, Dr. Robinson reported to the Johnson Space Center in March 1995. He completed a year of training and evaluation and was assigned to the Shuttle Avionics Integration Laboratory (SAIL) for the Astronaut Office Computer Support Branch. In 1997 he flew as a mission specialist on STS-85 and logged over 284 hours in space. Dr. Robinson is assigned to the crew of STS-95. This mission will support a variety of research payloads including deployment of the Spartan solar-observing spacecraft, the Hubble Space Telescope Orbital Systems Test Platform, and investigations on space flight and the aging process. STS-95 is scheduled for launch in October 1998.

STS-85 (August 7-19, 1997) was a 12-day mission during which the crew deployed and retrieved the CRISTA-SPAS payload, operated the Japanese Manipulator Flight Demonstration (MFD) robotic arm, studied changes in the Earth's atmosphere and tested technology destined for use on the future International Space Station. The mission was accomplished in 189 Earth orbits, traveling 4.7 million miles in 284 hours and 27 minutes.

FEBRUARY 1998

# STS-95

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## Crew Profile

Scott E. Parazynski



**NAME:** Scott E. Parazynski (M.D.)  
NASA Astronaut

**PERSONAL DATA:**

Born July 28, 1961, in Little Rock, Arkansas. Considers Palo Alto, California, and Evergreen, Colorado, to be his hometowns. Married to the former Gail Marie Vozzella. They have one son. He enjoys mountaineering, rock climbing, flying, scuba diving, skiing, travel, wood working and nature photography. A commercial, multi-engine, seaplane and instrument-rated pilot, Dr. Parazynski has logged over 1200 flight hours in a variety of aircraft.

**EDUCATION:**

Attended junior high school in Dakar, Senegal, and Beirut, Lebanon. Attended high school at the Tehran American School, Iran, and the American Community School, Athens, Greece, graduating in 1979. He received a bachelor of science degree in biology from Stanford University in 1983, continuing on to graduate with honors from Stanford Medical School in 1989. He served his medical internship at the Brigham and Women's Hospital of Harvard Medical School (1990). He had completed 22 months of a residency program in emergency medicine in Denver, Colorado when selected to the astronaut corps.

**ORGANIZATIONS:**

Member of the Aerospace Medical Association, the American Society for Gravitational and Space Biology, the Wilderness Medical Society, the American Alpine Club, the Association of Space Explorers, the Experimental Aircraft Association, and the Aircraft Owners and Pilots Association.

**SPECIAL HONORS:**

National Institutes of Health Predoctoral Training Award in Cancer Biology (1983); Rhodes Scholarship finalist (1984); NASA Graduate Student Researcher's Award (1988); Stanford Medical Scholars Program (1988); Research Honors Award from Stanford Medical School (1989); NASA-Ames Certificate of Recognition (1990); Wilderness Medical Society Research Award (1991); NASA Space Flight Medals (1994, 1997).

While in medical school he competed on the United States Development Luge Team and was ranked among the top 10 competitors in the nation during the 1988 Olympic Trials. He also served as an Olympic Team Coach for the Philippines during the 1988 Olympic Winter Games in Calgary,



Canada.

**EXPERIENCE:**

While an undergraduate at Stanford University, Dr. Parazynski studied antigenic variation in African Sleeping Sickness, using sophisticated molecular biological techniques. While in medical school, he was awarded a NASA Graduate Student Fellowship and conducted research at NASA-Ames Research Center on fluid shifts that occur during human space flight. Additionally, he has been involved in the design of several exercise devices that are being developed for long-duration space flight, and has conducted research on high-altitude acclimatization. Dr. Parazynski has numerous publications in the field of space physiology, and has a particular expertise in human adaptation to stressful environments.

**NASA EXPERIENCE:**

Selected by NASA in March 1992, Dr. Parazynski reported to the Johnson Space Center in August 1992. He completed one year of training and evaluation, and was qualified for future flight assignment as a mission specialist. Dr. Parazynski initially served as one of the crew representatives for extravehicular activity in the Astronaut Office Mission Development Branch. Following his first flight he was assigned as a backup for the third American long-duration stay aboard Russia's Space Station Mir, and was expected to serve as a prime crew member on a subsequent mission. He spent 5-months in training at the Gagarin Cosmonaut Training Center, Star City, Russia. In October 1995, when sitting-height parameters raised concerns about his fitting safely in the Soyuz vehicle in the event of an emergency on-board the Mir station, he was deemed too tall for the mission and was withdrawn from Mir training. He served as the Astronaut Office Operations Planning Branch crew representative for Space Shuttle, Space Station and Soyuz training, and was assigned to the Astronaut Office EVA Branch, helping to develop tools and procedures for the assembly of the International Space Station. A veteran of two space flights, STS-66 in 1994 and STS-86 in 1997, Dr. Parazynski has logged over 521 hours in space including over 5 hours of EVA (extravehicular activity). Dr. Parazynski is currently assigned to the crew of STS-95, where he will serve as the flight engineer. This mission will support a variety of research payloads including deployment of the Spartan solar-observing spacecraft, the Hubble Space Telescope Orbital Systems Test Platform, and investigations on space flight and the aging process. STS-95 is scheduled for launch in October 1998.

**SPACEFLIGHT EXPERIENCE:**

The STS-66 Atmospheric Laboratory for Applications and Science-3 (ATLAS-3) mission was launched from Kennedy Space Center, Florida, on November 3, 1994, and returned to land at Edwards Air Force Base, California, on November 14, 1994. ATLAS-3 was part of an on-going program to determine the earth's energy balance and atmospheric change over an 11-year solar cycle, particularly with respect to humanity's impact on global ozone distribution. Dr. Parazynski had responsibility for a number of on-orbit activities including operation of the ATLAS experiments and

Spacelab Pallet, as well as several secondary experiments in the crew cabin. He and his crewmates also successfully evaluated the Interlimb Resistance Device, a free-floating exercise he developed to prevent musculoskeletal atrophy in microgravity. The Space Shuttle Atlantis circled the earth 175 times and traveled over 4.5 million miles during its 262 hour and 34 minute flight.

STS-86 Atlantis (September 25 to October 6, 1997) was the seventh mission to rendezvous and dock with the Russian Space Station Mir. Highlights of the mission included the exchange of U.S. crew members Mike Foale and David Wolf, the transfer of 10,400 pounds of science and logistics, and a joint American-Russian spacewalk. Dr. Parazynski served as the flight engineer (MS2) during the flight, and was also the navigator during the Mir rendezvous. Dr. Parazynski and Russian cosmonaut Vladimir Titov performed a 5 hour, 1 minute spacewalk during which they retrieved four experiment packages first deployed during the STS-76 Shuttle-Mir docking mission. They also deployed the Spektr Solar Array Cap, which may be used in a future Mir spacewalk to seal a leak in the Spektr module's damaged hull. Other objectives of EVA included the evaluation of common EVA tools to be used by astronauts wearing either Russian or American-made spacesuits, and a systems flight test of the Simplified Aid for EVA Rescue (SAFER). The Space Shuttle Atlantis circled the earth 169 times and traveled over 4.2 million miles during its 259 hour and 21 minute flight, landing at the Kennedy Space Center.

APRIL 1998

Updated: 10/07/1998

## Crew Profile

Pedro Duque



**NAME:** Pedro Duque  
ESA Astronaut

**PERSONAL DATA:**  
Born March 14, 1963 in Madrid, Spain. Enjoys diving, swimming and cycling.

**EDUCATION:**  
Received a degree in Aeronautical Engineering from the Escuela Técnica Superior de Ingenieros Aeronáuticos, Universidad Politécnica, Madrid, Spain, in 1986.

**SPECIAL HONORS:**  
Awarded the "Order of Friendship" by President Yeltsin of the Russian Federation (March 1995).

**EXPERIENCE:**  
During Duque's studies, he worked on a flight simulator project in the laboratory of Flight Mechanics on a fellowship, and on the computation of environmental torques on spacecraft, under ESA contract. He joined GMV (Grupo Mecánica del Vuelo) in 1986, and in the same year he became the technical leader in a helicopter rotor simulation project. At the end of 1986, Duque was sent as contracted staff to ESA's European Space Operations Center (ESOC) in Darmstadt Germany, to work within the Precise Orbit Determination Group. From 1986 to 1992, he worked on the development of models for orbit determination, algorithms and implementation of orbit computation software. He was also part of the Flight Control Team (Orbit Determination) of ESA's ERS-1 and EURECA satellites. In May 1992, Duque was selected to join the Astronaut Corps of the European Space Agency (ESA) based at the European Astronauts Centre (EAC) in Cologne, Germany. In 1992 he completed the Introductory Training Program at EAC and a four-week training program at TsPK (the Russian Astronauts Training Centre) in Star City, Russia, with a view to future ESA-Russian collaboration on the Mir Space Station. From January to July 1993, he performed Basic Training at EAC.

In August 1993, Duque returned to TsPK to train in preparation for the joint ESA-Russian EUROMIR 94 mission. Training led to qualification as Research Astronaut for Soyuz and Mir. In May 1994, he was selected as member of crew 2 (backup) joining Yuri Gidzenko and Sergeij Avdeev. During the EUROMIR 94 mission which took place from October 3, 1994 to November 4, 1994, Duque was the prime Crew Interface Coordinator in the

Russian Mission Control Centre (TsUP).

In January 1995, Duque began an extended training course on Russian space systems in Star City and supported the second joint ESA-Russian mission, EUROMIR 95.

**NASA EXPERIENCE:**

In May, 1995, Duque was selected as an Alternate Payload Specialist astronaut for the Life and Microgravity Spacelab (LMS) mission, STS-78, flown in June-July, 1996. During this seventeen day mission Duque worked with the Crew Interface Coordinators as the interface between the investigators on ground and the crew onboard Columbia for all experiment related issues. ESA had five major facilities on the flight and was responsible for more than half of the experiments performed. In July 1996 he was selected by ESA to attend NASA Astronaut Candidate Training. Duque reported to the Johnson Space Center in August 1996 for two years of training and evaluation. He was initially assigned to the Computer Support Branch of the Astronaut Office, supporting Space Shuttle and International Space Station Programs and advanced technology development. Duque is currently assigned to the crew of STS-95. This mission will support a variety of research payloads including deployment of the Spartan solar-observing spacecraft, the Hubble Space Telescope Orbital Systems Test Platform, and investigations on space flight and the aging process. STS-95 is scheduled for launch in October 1998.

APRIL 1998

Updated: 10/07/1998

## Crew Profile

Chiaki Mukai



**NAME:** Chiaki Mukai (M.D., Ph.D.)  
NASA Astronaut (Payload Specialist)

**PERSONAL DATA:**

Born May 6, 1952, in Tatebayashi, Gunma Prefecture, Japan. Married to Makio Mukai, M.D., Ph.D.  
Recreational interests include snow skiing, Alpine competitive skiing, bass fishing, scuba diving, tennis, golf, photography, American Literature, and traveling.

**EDUCATION:**

Graduated from Keio Girls' High School in Tokyo, in 1971. She received her doctorate in Medicine, Keio University School of Medicine, 1977; a doctorate in physiology, Keio University School of Medicine, 1988; board certified as a cardiovascular surgeon, Japan Surgical Society, 1989.

**ORGANIZATIONS:**

The American Aerospace Medical Association; Japan Society of Microgravity Applications; Japan Society of Aerospace and Environmental Medicine; Japanese Society for Cardiovascular and Thoracic Surgery; Japan Surgical Society.

**SPECIAL HONORS:**

Outstanding Service Award - The Society of Japanese Women Scientist (1996), Special Congressional Recognition - U.S. Congress (1995), Happy Hands Award - Sate Junior Chamber of Commerce (1995), Aeromedical Association of Korea Honorary Membership (1995), Tatebayashi Children's Science Exploratorium Honorary President (1995), Prime Minister's Special Citation for Contributions to Gender Equality (1995), The De La Vaux Medal - The Federation Aeronautique Internationale(1995), The Award for Distinguished Service in Advancement of Space Biology - Japanese Society for Biological Sciences in Space (1995), Prime Minister's Special Citation (1994), Minister of State for Science and Technology's Commendation (1994 & 1992), People of Gunma Prefecture's Certificate of Appreciation (1994), Honorary Citizen of Tatebayashi City (1994), Outstanding Service Award - National Space Development Agency of Japan (1994 & 1992), Award for Distinguished Accomplishments - Tokyo Women's Foundation ( 1994) and Commendation for Technology - Japan Society of Aeronautical and Space Science ( 1993).

**PUBLICATIONS:**

Dr. Mukai is credited with approximately sixty publications since 1979.

**EXPERIENCE:**

Board certified for Medicine in 1977. From 1977 through 1978, Dr. Mukai worked as a Resident in General Surgery, Keio University Hospital, Tokyo. She was on the Medical Staff in General Surgery, Shimizu General Hospital, Shizuoka Prefecture in 1978, and on the Medical Staff in Emergency Surgery, Saiseikai Kanagawa Hospital, Kanawaga Prefecture in 1979. Dr. Mukai began her work as a Resident in Cardiovascular Surgery, Keio University Hospital in 1980 and served on the Medical Staff in Cardiovascular Surgery, Saiseikai Utsunomiya Hospital, Tochigi Prefecture in 1982. She returned to Keio University Hospital in 1983 as the Chief Resident in Cardiovascular Surgery, and was later promoted to Assistant Professor of the Department of Cardiovascular Surgery, Keio University. As a NASDA science astronaut, she became a visiting scientist of the Division of Cardiovascular Physiology, Space Biomedical Research Institute, NASA Johnson Space Center from 1987 through 1988. Dr. Mukai remains a Research Instructor of the Department of Surgery, Baylor College of Medicine, Houston, Texas and a visiting associate professor of the Department of Surgery, Keio University School of Medicine, Tokyo, respectively since 1992.

**NASA EXPERIENCE:**

In 1985, Dr. Mukai was selected by the National Space Development Agency of Japan (NASDA), as one of three Japanese Payload Specialist candidates for the First Material Processing Test (Spacelab-J) which flew aboard STS-47. Dr. Mukai has logged over 353 hours in space. She flew aboard STS-65 in 1994, and is the first Japanese female to fly in space. She is presently serves as a back-up payload specialist for the Neurolab (STS-90) mission, scheduled for launch in April, 1998. A NASDA science astronaut, Dr. Chiaki Mukai is assigned as a payload specialist on the crew of STS-95. This mission will support a variety of research payloads including deployment of the Spartan solar-observing spacecraft, the Hubble Space Telescope Orbital Systems Test Platform, and investigations on space flight and the aging process. STS-95 is scheduled for launch in October 1998.

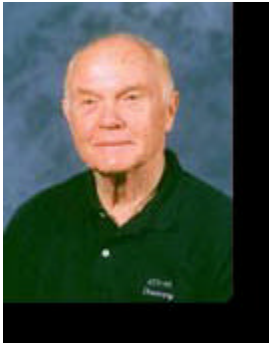
**SPACE FLIGHT EXPERIENCE:**

STS-65 Columbia (July 8-23, 1994) was the second International Microgravity Laboratory (IML-2) flight. The mission consisted of 82 investigations of Space Life Science (Human Physiology, Space Biology, Radiation Biology, and Bioprocessing) and Microgravity Science (Material Science, Fluid Science and Research on the Microgravity Environment and Countermeasures). IML-2 was also designated as an extended duration orbit mission focusing on medical experiments related to the cardiovascular system, autonomic nerve system, and bone and muscle metabolism. The mission was accomplished in 236 orbits of the Earth, traveling over 6.1 million miles in 353 hours and 55 minutes.

FEBRUARY 1998

## Crew Profile

John H. Glenn



**NAME:** John Herschel Glenn, Jr. (Colonel, USMC, Ret.)  
NASA Astronaut

**PERSONAL DATA:**

Born July 18, 1921 in Cambridge, Ohio. Married to the former Anna Margaret Castor of New Concord, Ohio. They have two grown children and two grandchildren.

**EDUCATION:**

Glenn attended primary and secondary schools in New Concord, Ohio. He attended Muskingum College in New Concord and received a Bachelor of Science degree in Engineering. Muskingum College also awarded him an honorary Doctor of Science degree in engineering. He has received honorary doctoral degrees from nine colleges or universities.

**SPECIAL HONORS:**

Glenn has been awarded the Distinguished Flying Cross on six occasions, and holds the Air Medal with 18 Clusters for his service during World War II and Korea. Glenn also holds the Navy Unit Commendation for service in Korea, the Asiatic-Pacific Campaign Medal, the American Campaign Medal, the World War II Victory Medal, the China Service Medal, the National Defense Service Medal, the Korean Service Medal, the United Nations Service Medal, the Korean Presidential Unit Citation, the Navy's Astronaut Wings, the Marine Corps' Astronaut Medal, the NASA Distinguished Service Medal, and the Congressional Space Medal of Honor.

**EXPERIENCE:**

He entered the Naval Aviation Cadet Program in March 1942 and was graduated from this program and commissioned in the Marine Corps in 1943. After advanced training, he joined Marine Fighter Squadron 155 and spent a year flying F-4U fighters in the Marshall Islands. During his World War II service, he flew 59 combat missions. After the war, he was a member of Marine Fighter Squadron 218 on the North China patrol and served on Guam. From June 1948 to December 1950 Glenn was an instructor in advanced flight training at Corpus Christi, Texas. He then attended Amphibious Warfare Training at Quantico, Virginia. In Korea he flew 63 missions with Marine Fighter Squadron 311. As an exchange pilot with the Air Force Glenn flew 27 missions in the F-86 Sabrejet. In the last nine days of fighting in Korea Glenn downed three MIG's in combat along the Yalu River.

After Korea, Glenn attended Test Pilot School at the Naval Air Test Center,

Patuxent River, Maryland. After graduation, he was project officer on a number of aircraft. He was assigned to the Fighter Design Branch of the Navy Bureau of Aeronautics (now Bureau of Naval Weapons) in Washington from November 1956 to April 1959, during which time he also attended the University of Maryland.

In July 1957, while project officer of the F8U Crusader, he set a transcontinental speed record from Los Angeles to New York, spanning the country in 3 hours and 23 minutes. This was the first transcontinental flight to average supersonic speed. Glenn has nearly 9,000 hours of flying time, with approximately 3,000 hours in jet aircraft.

#### **NASA EXPERIENCE:**

Glenn was assigned to the NASA Space Task Group at Langley, Virginia, in April 1959 after his selection as a Project Mercury Astronaut. The Space Task Group was moved to Houston and became part of the NASA Manned Spacecraft Center in 1962. Glenn flew on Mercury-6 (February 20, 1962) and has logged 4 hours, 55 minutes, 23 seconds in space. Prior to his flight, Glenn had served as backup pilot for Astronauts Shepard and Grissom. When astronauts were given special assignments to ensure pilot input into the design and development of spacecraft, Glenn specialized in cockpit layout and control functioning, including some of the early designs for the Apollo Project. Glenn resigned from the Manned Spacecraft Center on January 16, 1964. He was promoted to the rank of Colonel in October 1964 and retired from the Marine Corps on January 1, 1965. He was a business executive from 1965 until his election to the United States Senate in November 1974 where he now serves. Glenn is assigned to serve as payload specialist on the crew of STS-95. This mission will support a variety of research payloads including deployment of the Spartan solar-observing spacecraft, the Hubble Space Telescope Orbital Systems Test Platform, and investigations on space flight and the aging process. STS-95 is scheduled for launch in October 1998.

#### **SPACE FLIGHT EXPERIENCE:**

On February 20, 1962, Glenn piloted the Mercury-Atlas 6 "Friendship 7" spacecraft on the first manned orbital mission of the United States. Launched from Kennedy Space Center, Florida, he completed a successful three-orbit mission around the earth, reaching a maximum altitude (apogee) of approximately 162 statute miles and an orbital velocity of approximately 17,500 miles per hour. Glenn's "Friendship 7" Mercury spacecraft landed approximately 800 miles southeast of KSC in the vicinity of Grand Turk Island. Mission duration from launch to impact was 4 hours, 55 minutes, and 23 seconds.

JUNE 1998



# STS-95

## Flight Plan

### Mission Milestones

DATE	TIME (EST)	DAY	MET	EVENT	CREW
10/29/98	02:00 PM	1	000/00:00:00	LAUNCH	Crew
10/29/98	04:30 PM	1	000/02:30:00	SPACEHAB ACTIVATION	MS3, MS1
10/29/98	12:45 PM	2	000/22:45:00	PANSAT DEPLOY SEQUENCE BEGINS	PLT, MS1, CDR
10/29/98	01:20 PM	2	000/23:20:00	PANSAT DEPLOY	CDR, PLT, MS1
10/31/98	12:45 PM	4	002/22:45:00	SPARTAN DEPLOY SEQUENCE BEGINS	MS1, MS2, CDR, PLT
10/31/98	01:47 PM	4	002/23:47:00	SPARTAN RELEASE	CDR, PLT, MS1, MS2
11/01/98	05:20 PM	4	003/03:20:00	U.S. NEWS CONFERENCE	CDR, PS2
11/03/98	03:25 PM	6	005/01:25:00	SPARTAN CAPTURE	CDR, PLT, MS1, MS2
11/04/98	01:00 PM	8	006/23:00:00	CREW NEWS CONFERENCE	Crew
11/06/98	05:45 AM	10	008/15:45:00	SPACEHAB DEACTIVATION	Crew
11/06/98	11:00 AM	10	008/21:00:00	DE-ORBIT BURN	CDR, PLT
11/06/98	12:04 PM	10	008/22:04:00	LANDING	Crew

Updated: 10/09/1998

# STS-95

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## Flight Plan

### Summary Timeline - Day 1

DATE	TIME (EST)	DAY	MET	EVENT	CREW
10/29/98	02:00 PM	1	000/00:00:00	LAUNCH	Crew
10/29/98	04:30 PM	1	000/02:30:00	SPACEHAB ACTIVATION	MS3, MS1
10/29/98	04:30 PM	1	000/02:30:00	HOST ACTIVATION	PLT, MS2
10/29/98	04:45 PM	1	000/02:45:00	IEH ACT	MS2, PLT
10/29/98	04:55 PM	1	000/02:55:00	CRYOTSU ACT	PLT, MS2
10/29/98	05:00 PM	1	000/03:00:00	SPARTAN ACTIVATION	PLT, MS2
10/29/98	09:05 PM	1	000/07:05:00	SPACEHAB BRIEFING	PLT
10/29/98	10:00 PM	1	000/08:00:00	PRE-SLEEP	Crew
10/29/98	01:00 AM	1	000/11:00:00	SLEEP	Crew

Updated: 10/06/1998

# STS-95

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## Flight Plan

### Summary Timeline - Day 2

DATE	TIME (EST)	DAY	MET	EVENT	CREW
10/29/98	09:00 AM	2	000/19:00:00	CREW WAKE	Crew
10/29/98	12:25 PM	2	000/22:25:00	SPACEHAB BRIEFING	MS1
10/29/98	12:45 PM	2	000/22:45:00	PANSAT DEPLOY	PLT, MS1, CDR
10/30/98	02:15 PM	2	001/00:15:00	RMS C/O	MS2, MS1
10/30/98	03:00 PM	2	001/01:00:00	PLB SURVEY	MS2, MS1
10/30/98	03:10 PM	2	001/01:10:00	ENOSE ACTIVATION	CDR
10/30/98	06:30 PM	2	001/04:30:00	PUBLIC AFFAIRS TV EVENT	CDR, PLT, PS2
10/30/98	08:30 PM	2	001/06:30:00	SPACEHAB BRIEFING	CDR
10/30/98	08:50 PM	2	001/06:50:00	PRE-SLEEP	Cmd
10/30/98	12:25 AM	2	001/10:25:00	SLEEP	Crew

Updated: 10/06/1998

# STS-95

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## Flight Plan

### Summary Timeline - Day 3

DATE	TIME (EST)	DAY	MET	EVENT	CREW
10/30/98	07:50 AM	3	001/17:50:00	CREW WAKE	Crew
10/30/98	12:10 PM	3	001/22:10:00	SPACEHAB BRIEFING	CDR
10/30/98	12:30 PM	3	001/22:30:00	GLENN EDUCATION EVENT (AUDIO ONLY)	CDR, PS2
10/31/98	06:00 PM	3	002/04:00:00	RNDZ TOOLS C/O	MS2, PLT
10/31/98	07:55 PM	3	002/05:55:00	SPACEHAB BRIEFING	MS1
10/31/98	08:50 PM	3	002/06:50:00	PRE-SLEEP	Crew
10/31/98	11:50 PM	3	002/09:50:00	SLEEP	Crew

Updated: 10/06/1998

# STS-95

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## Flight Plan

### Summary Timeline - Day 4

DATE	TIME (EST)	DAY	MET	EVENT	CREW
10/31/98	07:50 AM	4	002/17:50:00	CREW WAKE	Crew
10/31/98	11:00 AM	4	002/21:00:00	SPACEHAB BRIEFING	MS3
10/31/98	11:55 AM	4	002/21:55:00	RMS PWRUP	MS1, MS2
10/31/98	12:10 PM	4	002/22:10:00	SPARTAN GRAPPLE	MS1, MS2
10/31/98	12:45 PM	4	002/22:45:00	SPARTAN DEPLOY	MS1, MS2, CDR, PLT
11/01/98	04:40 PM	4	003/02:40:00	GRP B POWRDOWN	PLT
11/01/98	05:20 PM	4	003/03:20:00	U.S. NEWS CONFERENCE	CDR, PS2
11/01/98	08:15 PM	4	003/06:15:00	PRE-SLEEP	Crew
11/01/98	11:15 PM	4	003/09:15:00	SLEEP	Crew

Updated: 10/06/1998

# STS-95

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## Flight Plan

### Summary Timeline - Day 5

DATE	TIME (EST)	DAY	MET	EVENT	CREW
11/01/98	07:15 AM	5	003/17:15:00	CREW WAKE	Crew
11/01/98	10:40 AM	5	003/20:40:00	PUBLIC AFFAIRS TV EVENT	CDR, MS3, PS2
11/02/98	04:40 PM	5	004/02:40:00	PUBLIC AFFAIRS TV EVENT	CDR, PS2
11/02/98	05:00 PM	5	004/03:00:00	RNDZ TOOLS SETUP	PLT, MS2
11/02/98	06:00 PM	5	004/04:00:00	SPACEHAB BRIEFING	MS1
11/02/98	07:40 PM	5	004/05:40:00	PRE-SLEEP	Crew
11/02/98	10:40 PM	5	004/08:40:00	SLEEP	Crew

Updated: 10/06/1998

# STS-95

## Flight Plan

### Summary Timeline - Day 6

DATE	TIME (EST)	DAY	MET	EVENT	CREW
11/02/98	06:40 AM	6	004/16:40:00	CREW WAKE	Crew
11/02/98	07:50 AM	6	004/17:50:00	GRP B POWERUP	CDR
11/02/98	10:05 AM	6	004/20:05:00	SPACEHAB BRIEFING	MS3
11/03/98	03:25 PM	6	005/01:25:00	SPARTAN CAPTURE	CDR, PLT, MS1, MS2
11/03/98	03:30 PM	6	005/01:30:00	SPARTAN BERTH	MS1, MS2
11/03/98	03:30 PM	6	005/01:30:00	GRP B POWRDOWN	CDR
11/03/98	07:05 PM	6	005/05:05:00	PRE-SLEEP	Crew
11/03/98	10:05 PM	6	005/08:05:00	SLEEP	Crew

Updated: 10/06/1998

# STS-95

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## Flight Plan

### Summary Timeline - Day 7

DATE	TIME (EST)	DAY	MET	EVENT	CREW
11/03/98	06:05 AM	7	005/16:05:00	CREW WAKE	Crew
11/03/98	01:10 PM	7	005/23:10:00	PUBLIC AFFAIRS TV EVENT	CDR, PLT, PS2
11/04/98	06:30 PM	7	006/04:30:00	PRE-SLEEP	Crew
11/04/98	09:30 PM	7	006/07:30:00	SLEEP	Crew

Updated: 10/06/1998



# STS-95

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## Flight Plan

### Summary Timeline - Day 8

DATE	TIME (EST)	DAY	MET	EVENT	CREW
11/04/98	05:30 AM	8	006/15:30:00	CREW WAKE	Crew
11/04/98	01:00 PM	8	006/23:00:00	CREW NEWS CONFERENCE	Crew
11/05/98	05:55 PM	8	007/03:55:00	PRE-SLEEP	Crew
11/05/98	08:55 PM	8	007/06:55:00	SLEEP	Crew

Updated: 10/06/1998

# STS-95

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## Flight Plan

### Summary Timeline - Day 9

DATE	TIME (EST)	DAY	MET	EVENT	CREW
11/05/98	04:55 AM	9	007/14:55:00	CREW WAKE	Crew
11/05/98	08:05 AM	9	007/18:05:00	SPACEHAB BRIEFING	MS1
11/05/98	08:45 AM	9	007/18:45:00	FCS CHECKOUT	CDR
11/05/98	09:10 AM	9	007/19:10:00	RCS HOTFIRE TEST	CDR
11/05/98	10:40 AM	9	007/20:40:00	CABIN STOW	MS2, PS2
11/05/98	11:40 AM	9	007/21:40:00	D/O BRIEF	CDR, MS2, PS2, PS1, MS1, MS3, PLT
11/06/98	04:40 PM	9	008/02:40:00	SPACEHAB BRIEFING	PLT
11/06/98	05:20 PM	9	008/03:20:00	PRE-SLEEP	Crew
11/06/98	08:20 PM	9	008/06:20:00	SLEEP	Crew

Updated: 10/06/1998

# STS-95

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## Flight Plan

### Summary Timeline - Day 10

DATE	TIME (EST)	DAY	MET	EVENT	CREW
11/06/98	04:20 AM	10	008/14:20:00	CREW WAKE	Crew
11/06/98	05:45 AM	10	008/15:45:00	SPACEHAB DEACTIVATION	Crew
11/06/98	06:45 AM	10	008/16:45:00	HOST DEACTIVATION	MS2
11/06/98	06:50 AM	10	008/16:50:00	IEH DEACT	MS2
11/06/98	06:55 AM	10	008/16:55:00	CRYOTSU DEACT	MS2
11/06/98	07:00 AM	10	008/17:00:00	DEORBIT PREP	PS, PLT, CDR, PS1, MS1, MS2, PS2
11/06/98	11:00 AM	10	008/21:00:00	DE-ORBIT BURN	CDR, PLT
11/06/98	12:04 PM	10	008/22:04:00	LANDING	Crew

Updated: 10/06/1998

## Payloads

### HST Orbital Systems Test Platform (HOST)

Payload Bay

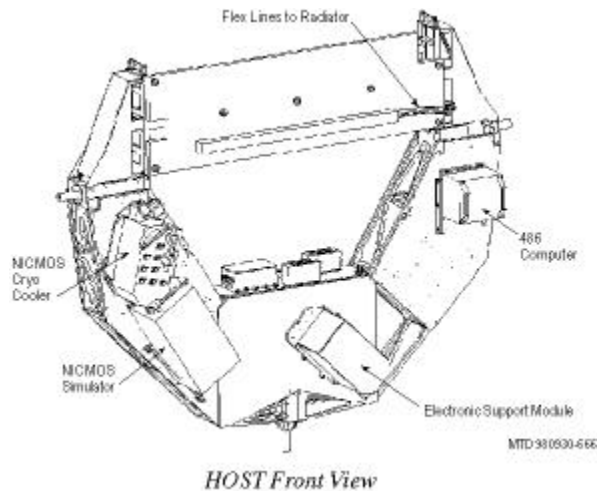
2,800 lb lbs.

**Prime:** Scott Parazynski

**Backup:** Stephen Robinson

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### Overview



The Hubble Space Telescope (HST) Orbital Systems Test (HOST) platform is an on-orbit test bed for hardware that will be installed on the orbiting telescope during the third HST servicing mission.

The primary objective of the HOST mission is to demonstrate that electronic and thermodynamic equipment slated for installation on the Hubble Telescope in 1999 works in the

radiation and microgravity environment.

One of the primary pieces of equipment to be tested is a new cooling system for the Near-Infrared Camera and Multi-Object Spectrometer, or NICMOS, that will extend the instrument's operational life at least five years. The NICMOS cooling system--a reverse turbo-Brayton cycle cooler and capillary pump loop--is a significant advancement in technology that may eliminate cooling systems that depend on Dewars to supply supercold liquids for cooling sensors.

NICMOS consists of three cameras that take pictures of objects at the far reaches of the universe. It can see objects created near the beginning of the universe and can look deep into clouds of dust to view how stars and planets are formed. NICMOS is also a spectrometer, a coronagraph, and a polarimeter.

NICMOS was installed on the Hubble Space Telescope on the second servicing mission in February 1997. It replaced the Faint-Object

Spectrograph.

The HOST mission will also test whether a new computer scheduled to be placed on the Hubble Telescope next year will operate in the radiation environment of space. The 486 computer will have twice the memory and three times the processor speed of the DF-224 computer and its coprocessor that it will replace. In addition to providing a measure of the 486 computer's performance, the HOST mission will also demonstrate the ability of the computer's hardware and software to handle errors.

The DF-224 computer has experienced a number of memory card failures and a few errors thought to have been caused by radiation. The HOST mission will allow investigators to discover any parts that are susceptible to radiation or single-event upsets. It will also demonstrate the 486 computer's handling of radiation-induced errors.

The pulse height analysis instrument will measure the actual radiation levels of heavy ions that cause single-event upsets in electronic devices. This information will be used to update the present models and aid in mapping the space environment. The improved models and maps can then be used to predict the frequency and intensity of SEUs.

A solid-state recorder that will replace the engineering science tape recorder as a flight spare on the Hubble Space Telescope will be tested during the HOST mission. The purpose of this test is to determine if the SSR is equivalent to the unit now on the Hubble Telescope, if the Hubble's current recorder is abnormal, and if the HOST SSR will operate properly on Hubble.

Errors were detected in the flight unit recorder on the telescope after it was installed during the second servicing mission. It is believed the errors were caused by single-event upsets or transients caused by high-energy protons in the South Atlantic Anomaly. The errors were not considered serious, but minor changes have been made in the SSR software to all but eliminate the chance that the recorder will lose science data.

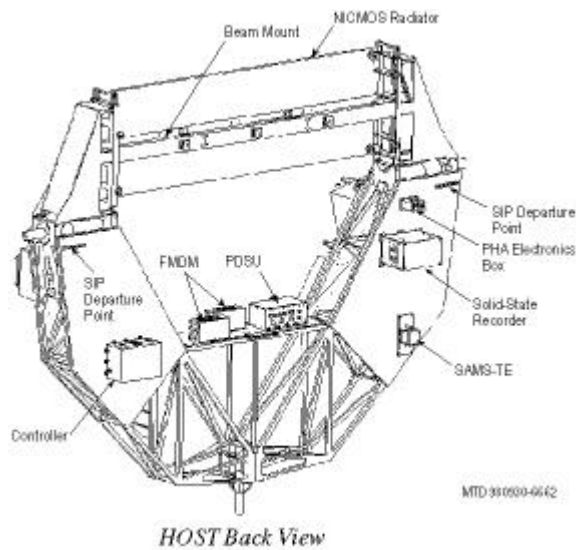
The current recorder on the Hubble has a second-order effect that appears to be induced by the initial errors and causes a second error. No explanation for this second error has been developed, and it may be unique to the Hubble recorder. The HOST will fly a second SSR to determine if it behaves similarly.

The HOST solid-state recorder will provide a very good comparison of the radiation levels in the Hubble Telescope and HOST orbits. Although the HOST mission environment is expected to be more benign than that of the Hubble orbit, the number of errors the recorder experiences in the HOST orbit will allow investigators to make a direct comparison of the two radiation environments.

HOST will also analyze the performance of fiber optics in the orbiter by

transmitting telemetry data to the orbiter over standard data lines and fiber-optic lines. The two data streams will be recorded for postflight analysis. Fiber-optic transmission is being considered for use on the orbiter to improve payload processing and to enable faster orbiter ground processing.

The platform for the HOST hardware is an airborne support equipment cradle originally designed to carry the Upper Atmosphere Research Satellite on STS-48 and now used as a carrier for contingency deployment and repair hardware. Protective enclosures, miscellaneous equipment, and honeycomb face sheets have been removed from the cradle and reconfigured to accommodate the HOST avionics and experiments.



Updated: 10/08/1998

# STS-95

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## Payloads

### International Extreme Ultraviolet Hitchhiker (IEH-3)

Payload Bay

5,672 lb lbs.

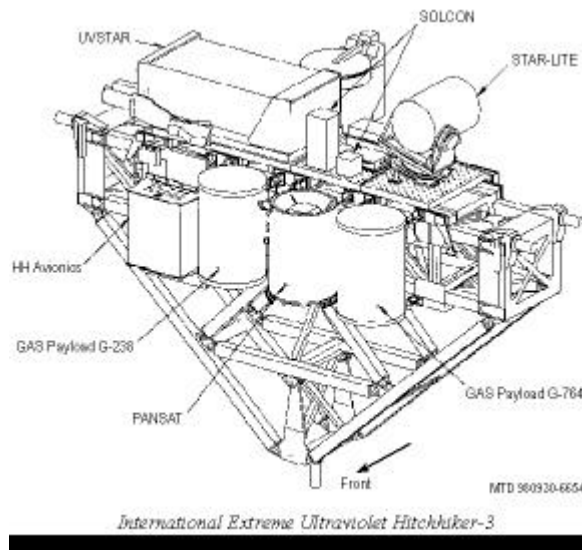
**Prime:** Stephen Robinson

**Principal Investigator:** Dr. Don McMullin

**Backup:** Scott Parazynski

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### Overview



The primary purpose of the IEH is to investigate the magnitude of the absolute solar extreme ultraviolet (EUV) flux and EUV emitted by the plasma torus system around Jupiter and stellar objects. It will also study the Earth's thermosphere, ionosphere, and mesosphere.

### SOLAR EXTREME ULTRAVIOLET HITCHHIKER

Developed by the University of Southern California for NASA's Solar System Exploration

Division, the SEH will measure the wavelengths of nonvisible light with an extreme ultraviolet (EUV) solar spectrometer and photograph the EUV region of the solar spectrum between 250 and 1,700 angstroms. (For comparison, visible light is between 4,000 and 7,000 angstroms. An angstrom is one ten-billionth of a meter.) SEH also will use helium and neon instruments to provide extremely accurate measurements of the brightness of solar EUV radiation.

On IEH-03, the solar system response to the solar input will be observed by a complementary set of instruments, UVSTAR and SEH. Both are international cooperative experiments. The UVSTAR instrumentation will provide Jovian system extreme ultraviolet/far ultraviolet data, and SEH will provide the required solar flux data for proper interpretation. Such missions will continue to provide the planetary community with the highest quality solar EUV data available.

One type of detector SEH is investigating is a helium double ionization cell. This detector measures the photoionization rate of helium, from which the total number of photons in emission lines between 50 and 504 angstroms can be calculated.

Commands sent from the ground trigger the release of a precise amount of helium into an ionization cell. Photons entering the cell collide with the helium atoms, which absorb the photons in the emission line being investigated. Electrons created in this process flow through electrometers to two collectors. The photoionization rate of the helium is calculated by comparing the currents of the two electrometers that serve each collector.

The neon rare-gas ionization cell is similar to the helium cell, but it provides the actual number of photons between 50 and 575 angstroms. In this detector, photons colliding with neon atoms create electrons and ions of neon. Electrons flowing through an ion current pico ammeter to a collector produce a current proportional to the photon count.

The silicon photodiode is a highly stable detector that measures the solar flux at EUV wavelengths. Solar photons enter the detector's 5mm aperture and pass through an aluminum filter. The light flux that is not filtered out (170 to 800 angstroms) strikes the aluminum-coated detector, creating a photocurrent that is measured by an electrometer.

The SEH EUV spectrometer measures the relative distribution of emission lines from 250 to 1,750 angstroms rather than the number of photons in the solar radiation. Radiation entering the instrument is broken into its component wavelengths. The photons then pass through a filter into a charged microchannel plate, where they crash into the glass surface of the plate. The collision produces electrons that impinge on a resistive anode detector, generating a current that is proportional to the intensity of the light.

Emission lines may be recorded with a spectrometer, an instrument that measures the intensity of radiation at particular wavelengths. The product of these measurements is a spectrograph, which reveals the chemical composition of the object being observed.

The data from these four instruments will be combined to reveal the absolute solar flux.

SEH will also measure changes in the Earth's atmosphere caused by solar EUV and daytime temperatures. Its observations will also be coordinated with those of two identical on-orbit instruments--a payload to be launched on a sounding rocket and the European Space Agency-NASA Solar and Heliospheric Observatory--to provide tight cross-calibration of the three instruments.

Dr. Don McMullin is the principal investigator.



## ULTRAVIOLET SPECTROGRAPH TELESCOPE FOR ASTRONOMICAL RESEARCH

The UVSTAR instrument complement consists of two telescopes with imaging spectrographs that cover overlapping spectral regions of 500 to 900 angstroms and 850 to 1,250 angstroms. The telescopes are capable of spectral imaging of extended plasma sources.

Internal gimbals allow the entire UVSTAR telescope/spectrograph assembly to move several degrees about its azimuth and elevation axes. A newly developed code autonomously determines the pointing direction of the telescope. Two smaller telescopes on the front of the UVSTAR instruments acquire and track targets after the orbiter is oriented to position the 6-by-8-degree field of view of UVSTAR's finder on the objects.

UVSTAR will obtain and spectrally resolve images of extended plasma sources. Key targets are planetary, such as the high-temperature plasma confined in a toroidal ring around Io's orbit at Jupiter, remnants of supernovae with their expanding envelopes, and the hot blue star content of the globular clusters (i.e., very dense stellar aggregates that give clues about stellar evolution). Targets of opportunity, such as comets or special sudden events occurring in the sky, also will be observed.

The volcanic Io spews volcanic gasses and materials that are trapped in Jupiter's magnetic field, forming a torus (a donut shape with Jupiter in the middle). The UV emissions from the torus will reveal the nature of the Ionian material and Jupiter's energy output.

UVSTAR is carrying an instrument called the extreme ultraviolet imager, which will measure the Earth's atmosphere in EUV wavelengths. The EUVI has two imagers that will map the intensity of helium and oxygen ions in the atmosphere by scanning along the Earth's shadow line. The EUVI will allow scientists to obtain precise measurements of the Earth's ionosphere and plasmosphere.

Since the crucial lines for interpreting the properties of the upper atmospheres and magnetospheric plasmas of planets and the structure of the interplanetary medium are situated in the 500- to 900-angstrom wave band, UVSTAR's extreme ultraviolet channel is perfect for conducting solar system research. Space-based measurements in the EUV spectrum offer scientists a more direct means of studying certain torus processes than ground-based observations of torus emissions in the visual wavelength.

The principal investigators are Dr. Lyle Broadfoot of the University of Arizona and Dr. Roberto Stalio of the University of Trieste.

## SOLAR CONSTANT EXPERIMENT

SOLCON's measurements will be used to calibrate instruments on satellites that are continuously monitoring the total solar irradiance. Since SOLCON

returns to Earth in the shuttle for recalibration, its TSI measurements are not subjected to possible degradation from solar radiation that other orbiting instruments may suffer. Ultimately, SOLCON gives researchers a "quality control" capability to check orbiting TSI instruments continuously.

The radiometer consists of two channels through which solar radiation may be sensed. Each channel contains a radiation sensor and has two apertures. The first aperture of each channel is protected by independent shutters that seal out any solar radiation from the radiation sensor when they are closed and allow the sensor to receive solar radiation when they are open.

The SOLCON flight operators will work with the Belgian Space Remote Operation Center at the Royal Meteorological Institute of Belgium and perform experiments in preparation for scientific research on board the International Space Station.

Dr. Dominique Crommelynck of the Royal Meteorological Institute is the principal investigator.

#### SPECTROGRAPH/TELESCOPE FOR ASTRONOMICAL RESEARCH

STAR-LITE is a telescope and imaging spectrograph that will study astronomical targets in the ultraviolet. Targets of scientific investigation include diffuse sky background emissions, scattered dust, and recombination emission lines from the hot and interstellar medium, supernova remnants, planetary and reflecting nebulae, star-forming regions in external galaxies and the torus formed around Jupiter by volcanic emissions of its moon Io.

Dr. Jay Holberg of the University of Arizona is the principal investigator.

#### PETITE AMATEUR NAVAL SATELLITE

PANSAT, a nonrecoverable satellite developed by the Naval Postgraduate School (NPS) in Monterey, Calif., is basically a small telecommunications satellite. It will be used to enhance the education of military officers at NPS by giving them hands-on experience in developing and operating a small satellite. It will also serve as a space-based laboratory for officers.

PANSAT is a spread-spectrum satellite. Spread spectrum allows communication satellites to capture and transmit signals that normally would be lost because the original signals were too weak or had too much interference.

Normal radio frequencies use about 3 kilohertz to 1 megahertz of bandwidth, but the spread spectrum is about a thousand times wider and difficult to intercept. The low probability of interception would be important to the military in situations like rescues of downed pilots. A downed pilot could obtain his location from the Global Positioning System and uplink the

data to an orbiting spread-spectrum satellite with minimum risk of interception by an enemy. Civilians could use this type of communication during emergency rescues and as a basis for establishing communication in remote areas.

PANSAT will demonstrate the capabilities of low-cost spread spectrum on a small satellite. It will provide store-and-forward digital communication using direct sequence, spread-spectrum modulation. Store-and-forward digital communication allows the PANSAT ground station to send data to the satellite. PANSAT will operate in the amateur radio frequency range to allow ham operators to evaluate the satellite's performance.

The PANSAT principal investigator is Rudolf Panholzer of the NPS.

#### COSMIC DUST AGGREGATION (G-764 GAS EXPERIMENT)

The CODAG experiment is designed to simulate the aggregation of dust particles and dynamics of dust clouds that occurred in the early stages of the formation of our solar system. Scientists hope that understanding the dust growth process in the early solar system will enable them to answer questions about planet formation.

The experiment apparatus consists of a vacuum chamber equipped with windows and sensors. Small glass particles will be injected into the chamber, and digital cameras will record the dust's motion in a small control area through microscopes. Sensors will measure the scattering characteristics of the dust cloud for comparison with astronomical measurements.

Ten experiment runs are planned. During each run, the dust will be observed for 15 minutes to five hours.

CODAG is sponsored by the University of Bremen, Germany, and ZARM (Zentrum für Angewandte Raumfahrttechnologie und Mikrogravitation).

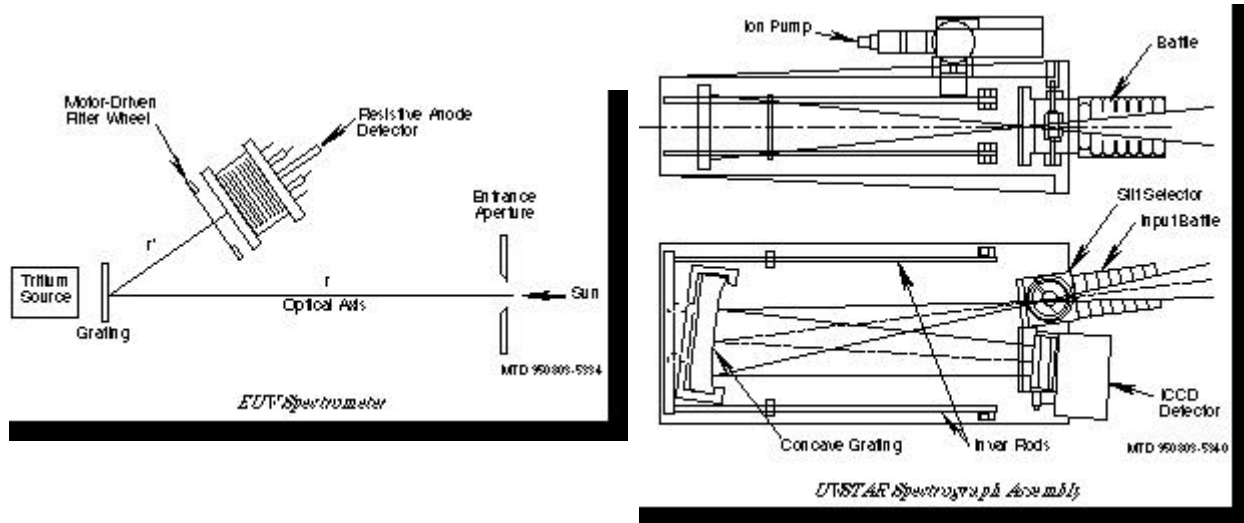
The principal investigator is Hans J. Koenighsmann.

#### ROACH EXPERIMENT (G-238 GAS EXPERIMENT)

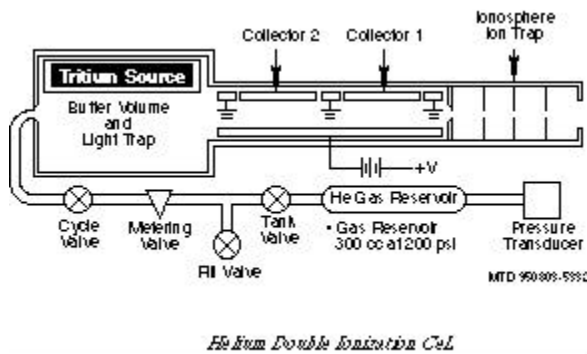
The only biological experiment on STS-95, G-238 will study the effects of space on the life cycle of the American cockroach. The payload is sponsored by the American Institute of Aeronautics and Astronautics and managed by students at DuVal High School in Lanham, Md.

The roach experiment apparatus consists of a habitat that has been divided into three sections: one for young adults, one for nymphs, and one for eggs. Air, heat, water, and food will be supplied. Battery-powered heaters will maintain a comfortable temperature in the habitat. An 8-mm camcorder will record activity inside the habitat at regular intervals.

David Eakman of The Boeing Company in Seabrook, Md., is the payload manager.



## History/Background



This is the third of five planned IEH shuttle missions to monitor long-term variations in the sun's EUV irradiance. The first flight was STS-69 in 1995. IEH consists of two cooperative experiments--the Solar Extreme Ultraviolet Hitchhiker (SEH) and the Ultraviolet Spectrograph Telescope for Astronomical Research, or UVSTAR.

The SEH and UVSTAR experiments are carried on a Hitchhiker cross-bay bridge in Discovery's cargo bay. SEH instrumentation is contained in a canister on the side of the Hitchhiker cross-bay bridge, and UVSTAR is mounted on a pallet on top of the bridge.

Five other payloads are hitching a ride with the IEH. The Spectrograph/Telescope for Astronomical Research payload will study astronomical targets in the ultraviolet. The Solar Constant experiment is designed to accurately measure the solar constant and identify variations in its value during a solar cycle. The Petite Amateur Naval Satellite is a small spread-spectrum communications satellite that will operate in the amateur radio ultrahigh frequency range. Two getaway specials are also part of the Hitchhiker payload complement.

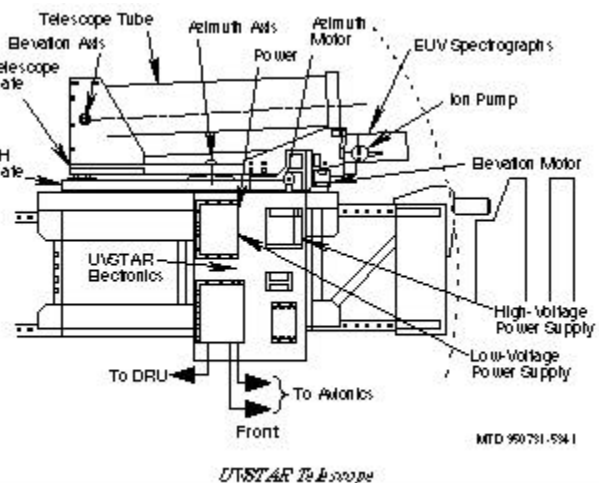
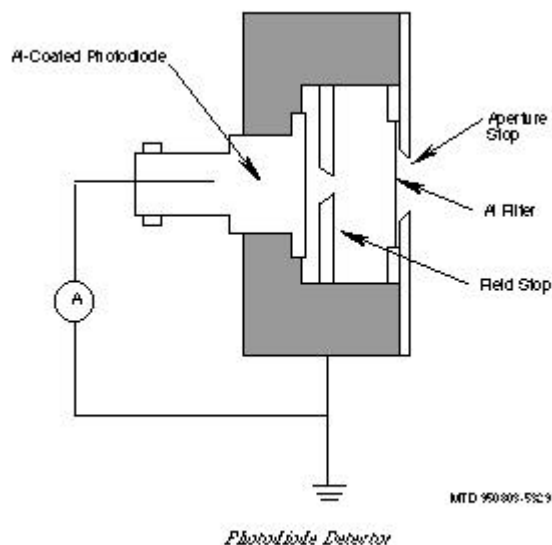
IEH-03 is managed by the Goddard Space Flight Center. The Hitchhiker avionics provide power to the payload and commanding capabilities from Goddard Payload Operations Control Center. Some of the payloads will be

controlled from the POCC; others will be run automatically by preprogrammed commands. The crew will support the IEH-03 payload by activating and deactivating it and performing attitude maneuvers in support of experiment observations.

The UVSTAR experiment, which was jointly developed by NASA and the Italian Space Agency, is a collaboration between the Universities of Arizona and Trieste. UVSTAR will use measurements of the solar flux recorded by the SEH to observe the response of the solar system to the solar input. The UVSTAR instruments will measure EUV emissions (500 to 900 angstroms) and far ultraviolet emissions (800 to 1,250 angstroms) from stellar objects such as hot stars and nebulae and the Jovian system.

The UVSTAR scientific program is an offshoot of the astronomy research conducted by the Voyager 1 and 2 spacecraft, which are sending back low-resolution spectra of faint stellar and nonstellar objects. UVSTAR's enhanced sensitivity and greater spectral resolution will allow it to study fainter objects and a greater variety of objects than the Voyager spectrometers, and its spectral imaging capabilities will enable it to study a wider range of objects.

The Belgian SOLCON is a unique instrument that is designed to ensure that spaceborne measurements of the absolute value of the solar constant (the total solar radiative power absorbed by one square meter at the outer layer of the Earth's atmosphere) remain accurate and precise. With its differential absolute radiometer, SOLCON will try to pinpoint the absolute value of the total solar irradiance with an accuracy of better than 0.01% and a precision better than 0.005%.



## Benefits

## SOLAR EXTREME ULTRAVIOLET HITCHHIKER

Since EUV flux, or radiation, cannot penetrate the Earth's atmosphere, scientists who want to learn more about this important energy source from the sun must conduct their experiments in space.

Scientists need accurate measurements of the sun's absolute EUV emissions to develop models of the scattering, ionization, and heating of planetary atmospheres (including our own), moons, and comets. Data from early attempts to measure EUV radiation exhibited rather large uncertainties caused primarily by instrument calibration uncertainties and difficulty separating changes in the sensitivity of instruments from the variability of solar EUV emissions.

Because of the stability of its three EUV detectors, the SEH can surmount these obstacles. When the SEH flew on STS-69, it produced the most reliable absolute solar EUV data so far.

Scientists hope that these experiments will provide data that will help them improve their global solar atmospheric models, which will lead to a better understanding of solar variability.

## SOLAR CONSTANT EXPERIMENT

Solar energy, Earth's only external source of energy, is a primary natural driver of climate changes. The measurement of total solar irradiance is an important tool for researchers who are studying the effects of global warming.

# STS-95

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## Payloads

### Cryogenic Thermal Storage Unit (CRYOTSU)

#### Payload Bay

**Prime:** Stephen Robinson

**Backup:** Scott Parazynski

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#### Overview

The CRYOTSU payload is a compilation of four cryogenic experiments -- a Thermal Storage Unit (TSU); a Cryogenic Capillary Pumped Loop (CCPL); a Cryogenic Thermal Switch (CTSW) and a Phase Change Upper End Plate (PCUEP).

The TSU, CCPL, and CTSW benefit future integrated cryogenic bus systems.

The PCUEP will benefit future cooling test bed missions and spacecraft requiring load-leveling for power dissipating components.

CRYOTSU is mounted in a Hitchhiker canister attached to an adapter beam mounted on the side wall of the Orbiter.

Updated: 10/08/1998

# STS-95

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## Payloads

### Biological Research in Canisters (BRIC)

In-Cabin

54 lb lbs.

**Prime:** Chiaki Mukai

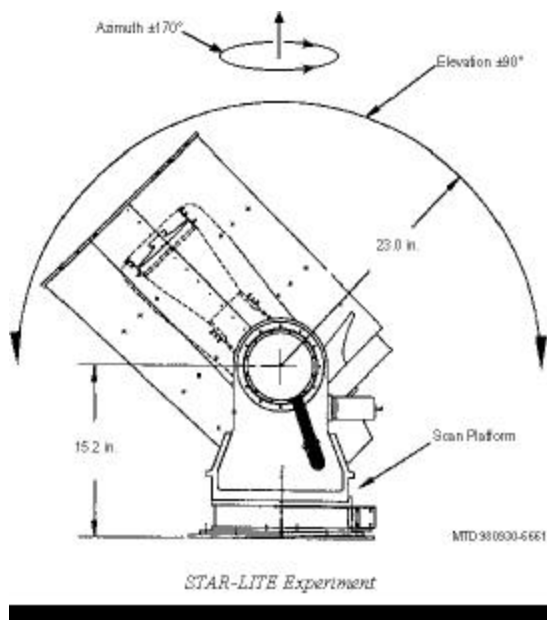
**Principal Investigator:** Robert Conger, University of Tennessee, Knoxville, Tenn.

**Backup:** Scott Parazynski

**Project Scientist:** William Knott, NASA Kennedy Space Center

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### Overview



NASA's Office of Life and Microgravity Sciences and Applications is sponsoring Biological Research in Canisters (BRIC) 13, the latest in a series of life sciences experiments designed to examine the effects of microgravity on a wide range of physiological processes in higher order plants and arthropod animals (e.g., insects, spiders, centipedes, crustaceans).

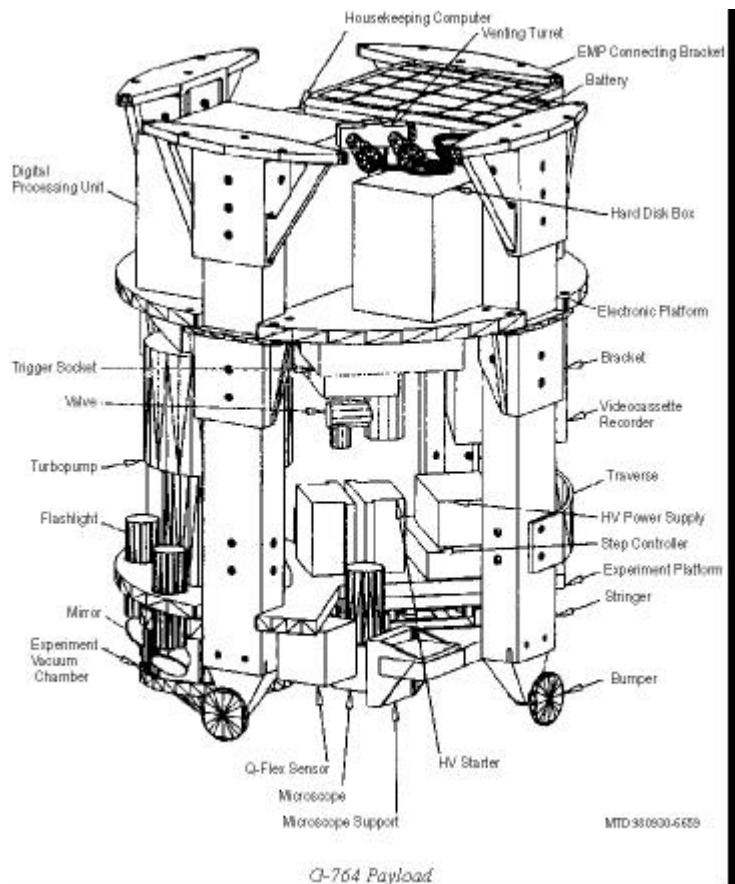
On STS-95, BRIC-13 will study the effects of microgravity on embryogenesis (the formation of embryos) in orchard grass.

Orchard grass samples will be obtained by splitting grass leaves in half and removing 3- to 4-mm segments from each half. The segments from one half will be flown in space; the segments from the other half will be used as a ground control in an identical experiment so that researchers can compare and analyze the effects of gravity and weightlessness on the same plant.

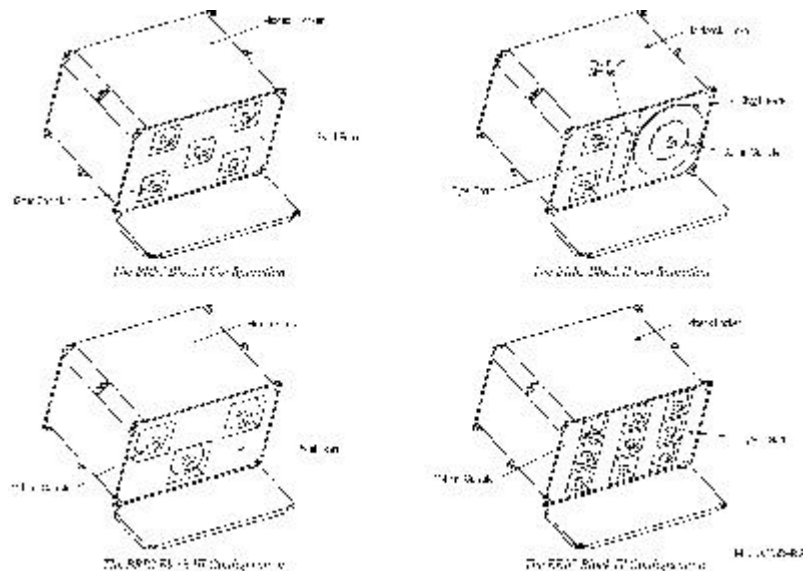
During the flight, a crew member will remove the plant segments from the BRIC canister. As the canister warms to room temperature, the embryos will begin to grow.

The Block III configuration of the BRIC hardware will be flown on STS-95. The BRIC cylinder can accommodate nine 100-mm petri dishes.





## History/Background



One of four BRIC payload hardware configurations is chosen for each flight to meet scientific requirements:

- o Block I: five 82-mm-diameter dual-chamber BRIC-60 canisters in a single middeck locker
- o Block II: two 82-mm-diameter dual-chamber BRIC-60 canisters, one pair of cryogenic gloves, and one gaseous-nitrogen freezer in a single middeck locker
- o Block III: three 114-mm-diameter single-chamber BRIC-100 canisters in a single middeck locker
- o Block IV: nine 114-mm-diameter single-chamber BRIC-VC canisters in a

## single middeck locker

The canisters are self-contained aluminum holders for the specimen support hardware and require no orbiter power. The canisters and freezer are housed in a standard middeck locker. The BRIC Block I, Block III, and Block IV experiment configurations require no crew interaction. The Block II configuration requires a crew member to put on a pair of insulating gloves, remove a canister from the locker, and replace it in the freezer.

BRIC-01 examined how microgravity affects the developing gypsy moth's diapause cycle--the period of time when the moth is in a dormant state undergoing development--with the aim of creating sterile moths. BRIC-02 focused on how plant tissue culture develops in microgravity. BRIC-03 studied the development and differentiation of soybeans as well as the effects of microgravity on the plants' carbohydrate metabolism, which provides plants the energy they need to grow. BRIC-04 examined how the hormone system and muscle formation processes of the tobacco hornworm (*Manduca sexta*) are affected by an altered gravitational field. BRIC-05 tested whether cell division changes observed in the daylily (*Heemerocallis* cultivar, Autumn Blaze) are caused by microgravity or other effects, such as the availability of water.

BRIC-06 studied how gravity is sensed within mammalian cells. The processing of outside signals by mammalian cells is complex. Gravity is one signal that is received by these cells, but the gravity-sensing mechanism in mammalian cells has not been identified. To study this intracellular signal transmission, BRIC-06 flew a unicellular eucaryote cell culture of slime mold (*Physarum polycephalum*) as a model system. The investigator examined the cultures for specific chemical concentrations that are signs of the signal transduction process.

BRIC-07 helped investigators discover the mechanisms behind one endocrine system in insects, which may aid in research on endocrine systems in general, including human systems. The BRIC-07 research is important to the space program because space flight is known to affect astronauts' endocrine systems.

The experiment began after the pupae, placed in the BRIC canisters before launch, started to develop. After the flight, the pupae were examined morphologically. More than half of the insects were sacrificed so investigators could collect and study their hemolymph, the circulatory fluid of invertebrates that is similar to the blood and lymph of vertebrates, and ecdysone, a hormone produced by insects that triggers molting and metamorphosis. The rest of the insects were allowed to develop to adulthood. During the 24 hours before the adult insects emerged, investigators removed their dorsolongitudinal flight muscles and analyzed their protein content and concentration.

BRIC-08 investigated the somatic embryogenesis of daylily plant cells.

BRIC-09 studied the influence of microgravity on genetically altered tomato and tobacco seedlings that had been modified to contain elements of soybean genes. This investigation provided information about plants' molecular biology and insight into understanding the transport and distribution mechanisms for hormones within plants. The research could provide crucial information on how to improve growth rates and biomass production of space-grown plants as well as information on how to enhance crop productivity on Earth.

BRIC-10 studied the effects of gravity on the growth, development, and metabolic processes in *Arabidopsis thaliana* and tobacco seeds. The investigation used the specimens to identify and clone genes whose expression is altered when the plants are grown in microgravity.

### **Benefits**

The BRIC-13 investigation will contribute to researchers' understanding of how the weightlessness of space affects the development of plants. Earlier studies conducted in space indicated that microgravity inhibits the earliest cell divisions that lead to embryo formation, which could result in seeds that are formed improperly or seeds that are unable to produce another generation of plants. The implications are important for the crews of future long-duration space flights because they will depend on plants grown in space for food, water, and oxygen.

Better understanding of embryo formation and cell division also could result in advances in medical technology and better pharmaceutical products.

## Payloads

### ELECTRONIC NOSE (E-NOSE)

In-Cabin

E-Nose weighs just over 3 pounds. Researchers thin lbs.

**Prime:** Curtis Brown

**Principal Investigator:** Dr. Margaret A. Ryan of JPL is the principal investigator for E-Nose. Dr. Margie L. Homer of JPL and Dr. John T. James of JSC are co-investigators.

**Backup:** Steven Lindsey

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### Overview

E-Nose is a new, miniature environmental monitoring instrument that detects and identifies a wide range of organic and inorganic molecules down to the parts-per-million level. The objective on STS-95 is to flight-test E-Nose and assess its ability to monitor changes in Discovery's middeck atmosphere.

The monitoring device uses an array of thin-film polymer sensors interspersed with carbon. The chemical sensors change resistance when exposed to vapors, but no one sensor is dedicated to identifying any specific vapor. Since gases and gas mixtures are identified by the electrical response pattern of the entire array, E-Nose has a unique ability to monitor and identify a wide variety of odors. For this flight, ten toxic compounds are targeted for identification.

In addition to the sensor array, the E-Nose flight equipment includes an alcohol wipe kit, a customized display and control palm-top for crew interface, and a valve assembly for collecting "grab" samples.

Once Discovery is in orbit, no sooner than 2.5 hours after launch, a crew member will unstow E-Nose from its middeck locker and set it up in a location with good return air flow and no stagnation, e.g., near the air revitalization system intake. Each day, preferably for 8 consecutive days, a crew member will collect ambient cabin air in a grab-sample container, wipe the detector instrument with alcohol to record a marker, and enter the event on a mission elapsed time log sheet, establishing a measurement baseline every 3 hours. E-Nose data will be stored internally for postflight analysis.

### History/Background

In the close confines of a spacecraft, the air that crew members breathe is filtered and recycled throughout the mission. Since the air supply is limited and very difficult to replace, the buildup of atmospheric contaminants is a concern to crew health. Such contaminants have been found in the shuttle crew cabin air. The accumulation of these potentially harmful gases poses a more serious threat during long missions aboard a space station or en route to distant bodies in the solar system.

In addressing these concerns, spacecraft designers must also deal with the usual size and weight restrictions placed on all spacecraft components. The challenge of maintaining air quality must be met with small, lightweight efficient systems. Hence the development by Jet Propulsion Laboratory (JPL) of a miniature air quality monitoring system, called the Electronic Nose because it operates in a manner similar to the human olfactory sense in detecting air changes.

## **Benefits**

Early detection of contaminants aboard spacecraft is vital to crew health. The problems with current air quality monitoring equipment may be solved by the extremely compact and unobtrusive design of E-Nose, which can detect, identify, and quantify a wide range of air constituents. This comprehensive measurement of spacecraft air quality by a miniature, distributed device also has potential application for environmental monitoring and control on Earth.

Updated: 10/08/1998

# STS-95

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## Payloads

### SPACE EXPERIMENT MODULE 4

Payload Bay

6 lb lbs.

**Prime:** Steven Lindsey

**Backup:** Curtis Brown

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#### Overview

STS-95 is the fifth SEM flight. The canister containing eight student experiment modules will remain in Discovery's payload bay, attached to the SPARTAN 201 support structure. The crew will activate the SEM carrier system as early in the mission as possible and deactivate it as late as possible. There will be no in-flight or uplinked control of individual experiments; data reduction and processing are performed after the flight. The experiments inside the SEM-04 carrier for STS-95 are as follows:

Effect of Microgravity and Temperature on Human Tissue and Human-Used and -Consumed Items  
Blue Mountain School, Floyd, Va.

Students from second to seventh grade are investigating the effect of microgravity and temperature on film, soap, motor oil, bone, nails, cola beverage, and popcorn. This experiment complements their study of the effects of microgravity on the human body and the development of products for use in space.

Curing Structural Adhesives and Solidifying Low-Melting-Point Solders in a Microgravity Environment  
Don Bosco Technical Institute, Rosemead, Calif.

The high school and junior college students at Don Bosco have designed a module containing two active experiments. One studies how microgravity affects the solidification of low-melting-point solders and solder wetting on gold plate. The other examines the structural integrity, tensile (or tension) strength, and adhesive cohesion of one-part epoxy or adhesive after exposure to microgravity.

Effects of Microgravity on an Objects Physical Characteristics  
Dowell Elementary School, Marietta, Ga.

First-grade students want to compare the weight, mass, and other physical characteristics of objects before and after space flight. The experiment objects include chewing gum (elasticity, mass), popcorn (percentage that will pop), bread (observation of mold), stickers (response of the adhesive), bubble wrap (inflation/deflation of bubbles), chalk (vibration, crumbling), paper clips (weight, mass), erasers (weight, mass, performance), and crayons (temperature effects).

Effect of Cosmic Radiation on Wisconsin Fast Plants and the Development of Brine Shrimp Eggs and Chia Seeds  
Fort Couch Middle School, Upper St. Clair, Penn., and Monrovia Elementary School, Madison, Ala.

Fifth- to eighth-grade students will look at the effect of cosmic radiation on Wisconsin fast plants (Brassica), wheat seeds, brine shrimp, and Chia seeds (the same seeds used on Chia Pets). Specifically, they will examine germination rate, crossover rate, life span, and changes in DNA. The investigation is part of the students developmental biology, genetics, and animal behavior curriculum.

Growing Montello Transglobally  
Montello High School, Montello, Wisc., and Istituto Technico Commerciale Riccati, Treviso, Italy

This project was jointly designed by high school students and staff from Montello, Wisc., and Montello, Italy. The two areas have many geographical similarities. Students will study lettuce and cicoria seeds and analyze statistics to compare germination for two to three generations. Specific observations will include plant size and vigor, bloom size, and productivity. The two sites will cross-compare data by exchanging seed samples, pictures, graphs, charts, diagrams and journals on the Internet.

Analysis of Three-Dimensional Sprag Performance in a Microgravity Environment  
University of Maryland, College Park, Md.

This is the first flight of the three-dimensional sprag, which was selected as one of the hundred most technologically significant new products in 1997. This innovative sprag was developed by Goddard Space Flight Center engineer John Vranish. Sprags are small parts manufactured with specialized geometry to allow free rolling in one direction and prevent motion in the other direction. The sprag's job is to lock a cog or wheel in place so that it moves in only one direction. The students will test and verify the sprag's performance in flight to evaluate its suitability as an alternative to conventional ratchet designs. In space flight and commercial applications, the sprag design is potentially valuable because it enhances tool efficiency: e.g., it will help conserve extravehicular activity resources (reducing human workload) in space, allow tools like wrenches to be used in more confined spaces, and enable tools that require no lubrication and can stay in space indefinitely. The experiment will record the response of

the sprag system at various applied torque levels.

#### Effect of Microgravity and Temperature on Mold Growth West Richland Elementary School, Noble, Ill.

To study the effect of microgravity and temperature on a variety of bread molds, students from kindergarten through sixth grade will measure and compare growth diameter, depth, and weight of controlled and microgravity-exposed mold cultures.

#### Effect of Microgravity on Seed Growth and Survival Woodmore Elementary School, Mitchellville, Md., and Colegio Santa Hilda, Buenos Aires, Argentina

Elementary students in Maryland and Argentina will characterize the effects of radiation on seed germination and growth by harvesting seeds from first-generation plants and repeating the germination and growth study for the second-generation seeds. A variety of seeds (e.g., perennial rye, Kentucky bluegrass, Black-Eyed Susan, corn, oats, barley, lentil, and sunflower) will be investigated. The two schools will share experiment data and results. The collaboration is designed to stimulate and enhance student cultural exchange.

### **History/Background**

NASA began the Space Experiment Module (SEM) program in 1995 as an offshoot of the Getaway Special program, managed by the Shuttle Small Payloads Project at Goddard Space Flight Center in Greenbelt, Md. Since 1982, GAS canisters had flown on the shuttle, offering economic access to space to a broader array of experimenters, particularly students. But participation was still somewhat limited by the high-level engineering skills required to design GAS experiments.

In 1995, the program directors started SEM to relieve students of the engineering burden and let them concentrate on creating their experiments. Since the module is equipped with electrical power, there is no need to engineer and build battery boxes, etc. Students of all ages can create, design, and build experiments with a little help from teachers or mentors. The experiments--which can be simple or complicated, active or passive--are placed in half-moon-shaped SEMs, ten of which are then stacked in a GAS canister.

SEM program accomplishments to date are as follows:

- National/international participation
- Involvement by diverse educational organizations, age groups, and levels
- Metropolitan, remote, and public schools
- Science and technical clubs
- Boy and girl scouts
- Status as a valid, legitimate, innovative, accessible educational tool



## **Benefits**

The specific objectives and benefits of the SEM program are listed below:

- Provide economical access to space for students from kindergarten to the university level.
- Use existing hardware and experience.
- Encourage hands-on student creation, design, implementation, and analysis of science and technology experiments with teacher or mentor guidance.
- Tie SEM program to NASA and U.S. educational goals and standards.
- Ensure that student participation is not limited by geographical location.
- Provide high-quality, reliable, usable products and responsive technical services.

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# STS-95

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## Payloads

### Getaway Special Program

#### Payload Bay

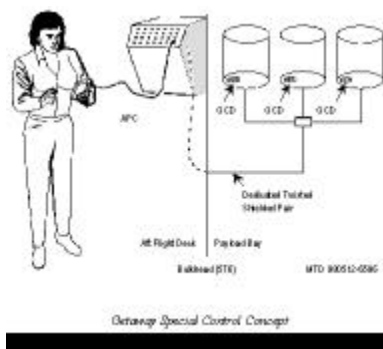
**Prime:** Steven Lindsey

**Principal Investigator:** see individual GAS payloads

**Backup:** Curtis Brown

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### Overview



STS-95 is the 33rd shuttle mission to participate in NASA's Getaway Special (GAS) program, officially known as the Small, Self-Contained Payloads program. The GAS program, which began in 1982, offers interested individuals or groups the opportunity to fly small experiments in space. It enhances education by making opportunities for hands-on space research available and generates new activities unique to space.

Customers also are able to inexpensively test ideas that could later grow into major space experiments.

To ensure that diverse groups have access to space, NASA rotates payload assignments among three major categories of users: educational, foreign and commercial, and U.S. government. Since the program was first announced in the fall of 1976, almost 200 GAS payloads have been reserved and flown by foreign governments and individuals; U.S. industrialists, foundations, high schools, colleges and universities; professional societies; service clubs; and many others. Although persons and groups involved in space research have obtained many of the reservations, a large number of spaces have been reserved by persons and organizations outside the space community.

There are no stringent requirements to qualify for space flight. However, each payload must meet specific safety criteria and be screened for its propriety as well as its educational, scientific, or technological objectives. These guidelines preclude commemorative items, such as medallions, that are intended for sale as objects that have flown in space.

GAS requests must first be approved at NASA Headquarters in Washington, D.C., by the director of the Transportation Services Office. At that point NASA screens the propriety objectives of each request. To

complete the reservation process for GAS payloads, each request must be accompanied or preceded by the payment of \$500 earnest money.

Approved requests are assigned an identification number and referred to the GAS team at the Goddard Space Flight Center, the designated lead center for the project. The GAS team screens the proposals for safety and provides advice and consultation on payload design. It certifies that proposed payloads are safe and will not harm or interfere with the operations of the space shuttle, its crew, or other experiments on the flight. The costs of any physical testing required to answer safety questions before launch are borne by the GAS customer.

NASA's space shuttle program has specific standards and conditions relating to GAS payloads. Payloads must fit NASA standard containers and weigh no more than 200 pounds. However, two or more experiments may be included in a single container if they fit in it and do not exceed weight limitations. The payload must be self-powered and not draw on the shuttle orbiter's electricity. In addition, payload designs should consider that the crew's involvement with GAS payloads will be limited to six simple activities (such as turning on and off up to three payload switches) because crew activity schedules do not provide opportunities to either monitor or service GAS payloads in flight.

The cost of this unique service depends on the size and weight of the experiment. Getaway specials of 200 pounds and 5 cubic feet cost \$10,000; 100 pounds and 2.5 cubic feet, \$5,000; and 60 pounds and 2.5 cubic feet, \$3,000. The weight of the GAS container, experiment mounting plate and its attachment screws, and all hardware regularly supplied by NASA is not charged to the experimenter's weight allowance.

The GAS container provides internal pressure, which can be varied from near vacuum to about one atmosphere. The bottom and sides of the container are always thermally insulated, and the top may be insulated or not, depending on the specific experiment. A lid that can be opened or one with a window may be required. These may also be offered as options at additional cost.

The GAS container is made of aluminum, and the circular end plates are 0.625-inch-thick aluminum. The bottom 3 inches of the container are reserved for NASA interface equipment, such as command decoders and pressure regulating systems. The container is a pressure vessel that can be evacuated before or during launch or on orbit and can be repressurized during reentry or on orbit, as required by the experimenter.

The getaway bridge, which is capable of holding 12 canisters, made its maiden flight on STS 61-C. The aluminum bridge fits across the payload bay of the orbiter and offers a convenient and economical way of flying several GAS canisters.

For additional information about NASA's Getaway Special program, contact

the program manager, Code MC, NASA Headquarters, Washington, D.C. 20546. The primary contact for payload users is the technical liaison, Code 740, NASA Goddard Space Flight Center, Greenbelt, Md. 20771.

## **STS-95 GETAWAY SPECIAL PAYLOADS**

Four Getaway Special (GAS) payloads will be aboard the STS-95 mission. G-467 and G-779 are described below. The other two GAS experiments, G-238 and G-764, are part of the International Extreme Ultraviolet Hitchhiker (IEH)-03 payload and are explained in the IEH-03 fact sheet.

### **G-467**

The objective of the G-467 GAS payload is to demonstrate in space the working principle and performance of a two-phase capillary pumped loop (CPL) with two advanced evaporators, a two-phase vapor quality sensor (VQS) with two condensers in parallel, and a control reservoir.

Capillary pumped loops are two-phase heat transfer systems that use wicks with small internal tubing to move the working fluid from the instrument that needs cooling to the spacecraft radiator for heat rejection to space. A two-phase flow loop system allows heat to be transferred but contains no moving parts and requires minimal power.

Another objective is to compare data on CPL behavior in low gravity with analytical predictions resulting from computer modeling and performance on Earth. The in-orbit experiment is to demonstrate that the CPL has the capability to operate under different heat loads imposed on two evaporators in parallel; to share heat load between two evaporators; to prime an evaporator by a controlled management of the reservoir fluid content; to start up from low-temperature conditions; and to adjust and maintain a temperature set point while operating under different heat load and sink conditions.

G-467 will also provide low-gravity calibration of the VQS, carry out simple control exercises to demonstrate the usefulness of a VQS for system control, and determine the performance limits of the CPL and its evaporators.

G-467 is a modified reflight of G-557, which was flown on STS-60 in February 1994. Experiment G-467 differs from G-557 by a new, more accurate controllable bypass valve and tuned vapor bypass line flow resistance; increased number of sensors; condensers in parallel instead of in sequence; new evaporator internal design; increased number of sensors; new flight scenario; update and extension of experiment controlling software; and updated position of reservoir-loop connection.

The G-467 GAS payload is sponsored by the European Space Agency, Paris, France. The payload manager for this experiment is Andre Robelet.

## **G-779**

G-779, or Hearts in Space, was developed by researchers at Bellarmine College in Louisville, Ky. The original Hearts in Space experiment (G-572) was initially flown aboard the space shuttle Discovery on STS-85 in August 1997. Because of the failure of a tape recorder electrical connector, which prevented the on-orbit recording of physiological pressure and flow data, the payload is being reflown.

The purpose of the payload is to study why astronauts' hearts become smaller while in space. NASA scientists have noted that the size of the heart, known as the ventricular volume index, decreases in astronauts following adaptation to weightlessness, usually by the second day. In addition to becoming smaller in size, the heart also pumps approximately 15 to 20 percent less blood per heartbeat (the stroke volume index) during zero gravity. The body automatically makes adjustments via hormones and nervous control that maintain blood pressure and heart rate so that the astronauts suffer no ill effects from the reduced size of the heart. The underlying physiological reason for these changes has never been explained.

The Hearts in Space experiment will demonstrate how these changes in cardiac size happen. The goal of the experiment is to prove that the biological changes to astronauts' hearts are directly attributable to the loss of gravity, since blood is weightless in space. On Earth, several factors cause the heart to fill, including the overall velocity and pressure of the blood entering the heart; how stiff or flaccid the muscles of the heart wall are; and the weight of the volume of blood in the heart (technically referred to as the gravitational acceleration-dependent hydrostatic pressure difference, that is, fluid pressure due to weight that is caused by gravity).

An analogy would be filling a water balloon. As the balloon fills, the weight of the water helps stretch the balloon, allowing more water to enter (the pressure and velocity of the water, and the stiffness of the balloon, also would be factors). The scientists' hypothesis is that the heart fills less (hence its size is reduced) because the incoming blood has no weight in space.

Researchers have calculated that the weight of the blood contributes about 15 to 20 percent of the total filling of the heart. Therefore, in space the heart should be 15 to 20 percent smaller because the blood is weightless. This is the same reduction seen on the echocardiographs taken during space flight. G-779 will document what the mathematical calculations predict and the echocardiographs show. Thus, the researchers hope to prove that the change in heart size is because of the lack of weight of the blood and not caused by other factors, such as fluid shifting in the body.

The science team has built an experimental apparatus consisting of an artificial human heart and mechanical circulatory system that simulates the blood pressure and flow in a normal adult. The payload uses the same

clinical artificial heart that has been implanted in patients with heart disease. Since the apparatus will not be influenced by normal biological reactions to zero gravity, such as hormone release, blood vessel constriction, nerve impulses, etc., scientists should get a more accurate picture of the physical forces affecting the heart in outer space.

In the astronauts, their bodies compensate for this loss in filling capacity by increasing the heart rate and constricting blood vessels so that blood flow and pressure stay normal, whereas the mechanical model that will fly on the shuttle allows researchers to study the changes in pressure and flow directly without the biological corrective measures.

Principal investigators are Thomas E. Bennett, Ph.D., Department of Biology, Bellarmine College, Louisville; George M. Pantalos, Ph.D., Department of Surgery, University of Utah, Salt Lake City; and M. Keith Sharp, Sc.D., Dept. of Civil Engineering, University of Utah, Salt Lake City.



Updated: 10/08/1998

# STS-95

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## Payloads

### SPACEHAB

Payload Bay

24,333 lbs.

**Prime:** Stephen Robinson

**Backup:** Pedro Duque

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### Overview

Much of the mission research will be performed in the SPACEHAB Single Research Module, a 10-foot by 13.5-foot pressurized (or "habitable") laboratory located in the Shuttle's cargo bay and connected to the middeck area of the orbiter. Crew access is through a tunnel system located between the Orbiter middeck and the SPACEHAB module.

### SPACEHAB CONFIGURATION

Designed to augment the Shuttle orbiter's middeck, the SPACEHAB Research Module provides a total cargo capacity of up to 4,800 pounds (7,200 kilograms) and contains systems necessary to support the habitat for the astronauts, such as ventilation, lighting and limited power. The STS-95 SPACEHAB payload consists of a pressurized module accommodating rack mounted experiments, soft stowage bags, lockers, and supporting subsystems.

### SPACEHAB CREW OPERATIONS

Generally two crewmembers are required for SPACEHAB operations. The SPACEHAB environmental control system is designed to nominally accommodate two crewmembers on a continuous basis. An additional crewmember is accommodated for brief periods at the expense of reduced cabin air heat rejection capability.

### SPACEHAB PAYLOAD SUMMARIES

#### Vestibular Function Experiment Unit (VFEU)

The Vestibular Function Experiment Unit (VFEU) aboard STS-95 will feature two marine fish, called Toadfish, as experiment subjects. Housed in the VFEU, the fish will be electronically monitored to determine the effect of gravitational changes on the inner-ear, or otolithic, system. The freely moving fish will provide physiological signals of the otolith nerves through an implanted, specially designed multi-pore electrode.

Measurements of afferent and efferent responses will be made before, during, and after the flight. This research will provide important information about mechano-sensory mechanisms in the human vestibular system and may be applied to therapy for equilibrium disorder or Earth-bound motion sickness

The VFEU experiment is powered on when the Fish Packages (FP) are installed at approximately L-35 hours and will run continuously until the FP's are removed at approximately R+5 hours. Responses of both the primary afferents and central nervous system efferent fiber will be continuously collected by way of the Neural Data Acquisition System (NDAS). The collected data will be recorded on the Data Recorder (DR). Pertinent experiment facility data will be downlinked for observation by VFEU ground personnel.

VFEU has been flown on three previous shuttle missions: STS-47 (SL-J), STS-65 (IML-2), STS-90 (Neurolab)

### **Biological Research in Canisters (BRIC)**

SPACEHAB's Biological Research in Canisters (BRIC) payload experiment is intended to provide researchers with flight opportunities for investigations into the effects of spaceflight on plant specimens and to investigate the effects of electrical fields on plant roots.

The growth and development of higher plants are strongly influenced by gravity, and cell walls play an important part in supporting the plant body under terrestrial gravity conditions. Therefore, physical properties of the cell wall will change greatly in the microgravity environment of space.

In this experiment, seedlings of rice and arabidopsis are cultivated in microgravity aboard the SPACEHAB module. The frozen cell wall samples returned from space will be analyzed for mechanical, enzymatic and structural changes.

The BRIC experiment consists of plant samples contained in petri dishes and support hardware. Crew will manipulate the samples on orbit and record plant growth with video and 35 mm cameras.

### **Oceaneering SPACEHAB Refrigerator Freezer (OSRF)**



The Oceaneering-SPACEHAB Refrigerator Freezer (OSRF), an advanced technology thermoelectric refrigerator freezer, is being flown for the first time on STS-95 in support of the BRIC and VFEU payloads.

The OSRF can be mounted as a double locker assembly in either the Orbiter middeck, replacing two standard stowage lockers, or in the SPACEHAB Module via a double experiment mounting plate. On STS-95, OSRF will operate in the SPACEHAB Module at 4.0 degrees C.

Capable of the supporting life sciences and other requirements aboard the Space Transportation System, OSRF offers a refrigerated payload volume of 1.85 ft<sup>3</sup> with minimal required maintenance. Each OSRF unit (including desiccant pack) weighs 80.27 pounds (without contents) and operates with continuous power of 70 Watts and 380 Watts peak.

STS-95 crewmembers will spend about 40 minutes total performing daily OSRF status checks.

### **Organic Crystal Growth Cell (OCC)**

The objective of the Organic Crystal Chamber (OCC) experiment is to investigate an anisotropic property of organic ferromagnet. Diffusing donor and acceptor materials into a reaction chamber containing the organic solvent will grow a large, high-quality, single crystal of organic ferromagnet. The intent is to obtain large, high-quality crystals of organic ferromagnet by diffusion methods from an organic donor and acceptor in an organic solvent under microgravity conditions.

Previous Flights of the OCC include re-flight of OCGP payload from STS-42 (IML-1). The experiment will consume one half-hour of crew time.

### **Advanced Gradient Heating Facility (AGHF)**

The AGHF experiment is a Bridgman furnace designed for directional solidification and crystal growth, featuring the capability of demarcation of the solidification front by Peltier pulse marking and of thermal coupling of the experiment cartridge to the cooling zone by means of a liquid metal ring. Contained in a SPACEHAB Single Rack, the AGHF includes an Electronics Module (ELM), the Core Facility Module (CFM), the Core Access Panel and the Gas Storage Module.

The AGHF will not be powered during launch and landing. On-orbit, the crew will configure the furnace for operation, vent the facility and verify establishment of a vacuum and perform a trial run.

Nine processing runs will be performed. When a processing run is completed, the crew will configure the furnace, either for the next run or for landing, as required. Following a given processing run, the furnace is

powered down; however, the electronics, the water cooling, and the air cooling are continuously running. Between experiment runs the furnace will be pressurized to cabin ambient, the processed cartridge removed and stowed, a fresh sample cartridge installed, and vacuum established in the furnace. If a delay greater than 60 minutes is scheduled between runs, the entire AGHF facility can be powered down after consultation with the AGHF ground control team.

### **Facility for Adsorption and Surface Tension (FAST)**

The Facility for Adsorption and Surface Tension (FAST), which will be housed in two SPACEHAB lockers, will be used to investigate surface phenomena at liquid-liquid and liquid-gas interfaces in microgravity to eliminate the effects of buoyancy- and gravity-driven convection. Principal scientific goals for FAST include: studies of the dynamic surface tension of water solution; dilation properties of surfaces by adsorption kinetic studies; and study of the interface between non-coalescing liquids.

The FAST hardware is not powered during the prelaunch/ascent phase of the mission. The experiment operations begin with the crew activating the FAST manual power switch. Once the crew switches on the power, the ground control team will send software commands to activate the science after the experiment reaches thermal equilibrium. The crew activities involve daily status checks of the FAST experiments; however, the operation and monitoring of the experiment will be controlled via ground commanding. After completion of all the experiment runs, the crew will shut off the experiment in preparation for the descent phase of the mission.

### **Advanced Protein Crystallization Facility (APCF)**

A veteran of four previous Shuttle missions, the APCF facility provides a cooled and heated volume that permits growth of protein crystals in microgravity. The units are locker-insert payloads and have flown on SPACEHAB and SpaceLab many times. The objective of the APCF experiment on STS-95 is to crystallize solution samples in orbital microgravity and to return them for post-flight analysis.

On STS-95, SPACEHAB is providing both lockers. The units have very few crew controls and are largely automated. APCF will require about 30 minutes of crew time.

During mission operations, the two APCFs, with reactors and sample materials, are inserted into SPACEHAB lockers and powered prior to launch. Once on-orbit, the Experiment Start switch command will start processing which will progress automatically through the pre-process stages. Daily status checks will be carried out with LED status recorded on the FDF cue card. Near mission end, the Experiment Stop switch command will cause the facility to go into its post-processing stage, shutdown, but remained powered.

## **BIOBOX**

BIOBOX is an incubator/refrigerator that will house several groups of samples that relate to human bone & cell growth. Experiment operations and monitoring are performed from the POCC.

## **Self-Standing Drawer - Morphological Transition and Model Substances**

SSD/MOMO is a reflight experiment from STS-84 which will melt a low temperature solid sample and record the melt zone on video. Crew will activate, status check, and deactivate the hardware.

## **Osteoporosis Experiment in Orbit (OSTEO)**

The OSTEO experiment is designed for the in-vitro evaluation of bone cell activity under microgravity conditions. Crew will perform sample feeding and fixation operations, daily status checks and experiment deactivation.

## **National Institute of Health Cell Culture Module - (NIH-C8)**

The Cell Culture Module (CCM) is a hardware unit designed specifically to aid in the study of microgravity effects at the cellular level. It utilizes hollow fiber bioreactor cartridges as the basic cell support structure and allows controlled physiologic maintenance, manipulation, and testing of cellular biology. Crew interaction involves in-flight activation, temperature recording twice per day, and deactivation.

## **Clinical Trial of Melatonin as Hypnotic for Space Crew (Sleep-2)**

The Sleep-2 experiment will evaluate the normal sleep patterns of crewmembers before, during, and after space flight in order to identify the factors that may be contributing to sleep disturbances that are known to occur during space flight. This experiment will also perform a preliminary evaluation of the effectiveness of the pineal hormone melatonin as a hypnotic during space flight. Crew activities include donning the sleep gear and manual testing of alertness during several flight days, as well as providing and processing urine samples.

## **Protein Turnover Experiment (PTO)**

The PTO experiment will study the effects of space flight on whole-body and skeletal muscle protein metabolism. Blood samples will be taken pre

mission, on-orbit as well as post mission. Two 24-hour urine collections are also required.

### **Commercial Protein Crystal Growth (CPCG)**

CPCG will produce high quality protein crystals in microgravity. The crew will activate and deactivate the experiments.

### **Microgravity Glovebox (MGBX)**

MGBX is a facility that allows safe manipulation of samples and the performance of experiments within a contained environment. Once the crew has set up the facility, the CDOT, CGEL, and IFFD experiments will be performed using the glovebox.

### **Commercial ITA Biomedical Experiments (CIBX)**

The CIBX experiment consists of two Commercial Refrigerator Incubator Modules (CRIMs) capable of containing various apparatus for the study of fluid and solid mixing and diffusion. The crew will set up, activate, monitor, log data, photograph, deactivate and stow the hardware on orbit.

### **Commercial Generic Bioprocessing Apparatus (CGBA)**

CGBA is designed to store, mix, and process biological samples in a microgravity environment. Crew will perform daily status checks.

### **Enhanced Orbiter Refrigerator Freezer (EORF)**

The EORF refrigerator/freezer will be powered on orbit and will remain powered through landing for cold storage of samples taken during the mission. Crew will activate the EORF, set the temperature, and monitor status twice daily.

### **Astroculture (ASC-8)**

Astroculture is a facility which will support two experiments during the STS-95 mission. One experiment, sponsored by International Flavors and Fragrances, Inc., New York City, is partnering with NASA's Commercial Center for Space Automation and Robotics. This experiment will study how microgravity affects the production of plant oils important to many consumer products. The crew is required to initiate experiments, download data, and terminate experiments.

### **Advanced Organic Separations (ADSEP)**

The ADSEP hardware provides the capability to separate and purify biological materials in microgravity with minimum crew interaction. The crew will activate the hardware, exchange sample modules, and deactivate the hardware.

### **Protein Crystallization Apparatus for Microgravity (PCAM 1)**

PCAM is a crystal growth facility for the production of large, high-quality protein crystals. The crew is required for activation and deactivation.

### **Biotechnology Dynamics - A (BIODYN-A)**

BIODYN-A will perform experiments aimed at providing aid in organ transplantation, diseases of the elderly, and diabetics. The crew will activate the hardware, perform daily status checks, and deactivate the hardware.

### **AEROGEL**

The Aerogel experiment will study the effects of microgravity on the formation of ceramic materials. The crew will activate and deactivate the hardware.

### **Microencapsulation Electrostatic Processing System (MEPS)**

The MEPS experiment will form microcapsules containing medicines to be used in the treatment of various diseases. The crew will activate the hardware, exchange processing chambers as runs are completed, and deactivate the hardware.

### **NHK Camera**

The NHK Camera is a high definition camcorder that will be flown as a replacement for an Orbiter camcorder and to certify this hardware for future flights on the International Space Station. The crew will destow, adjust and setup the hardware, record as required, disassemble and stow the hardware.

### **History/Background**

STS-95 represents the 12th flight of Vienna, Va.-based SPACEHAB's privately developed research and re-supply modules. This flight is the first of three future SPACEHAB science or cargo-carrying missions included under a \$43 million contract the company signed with the U.S. space agency in December 1997.

Updated: 10/08/1998

# STS-95

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## Payloads

### SPARTAN 201-5

Payload Bay

2,978 lbs.

**Prime:** Scott Parazynski

**Backup:** Stephen Robinson

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### Overview

SPARTAN 201 is a free-flying payload that will study the solar wind and the sun's corona to increase our knowledge of our star's effects on the Earth. The satellite will be deployed and retrieved by the shuttle orbiter Discovery.

The SPARTAN carrier is a simple, reusable vehicle that can carry a variety of scientific instruments at a relatively low cost. After it is deployed from the orbiter in space, it provides its own power, pointing, and data recording as it performs a preprogrammed mission. In addition to solar experiments, the SPARTAN spacecraft can be programmed to conduct stellar astronomy, Earth fine pointing, spacecraft technology experiments and demonstrations, and microgravity science and technology experiments.

The SPARTAN project offers the scientific community an intermediate capability for conducting investigations in space between that afforded by small payloads that remain in the orbiter and larger satellites that orbit the Earth for long periods of time.

The SPARTAN 201 series is investigating the solar corona--the thin upper layers of the sun's atmosphere, which reach temperatures of about 2 million degrees Fahrenheit. Scientists hope to determine the mechanisms that cause the heating of the corona and the acceleration of the solar wind, which originates in the corona, and explain why the corona is so much hotter than the rest of the sun. The first three SPARTAN 201 flights have already advanced our understanding of the solar wind and its origin.

SPARTAN 201-05 observations will be coordinated with observations made from the Solar and Heliospheric Observatory (SOHO) satellite, a cooperative mission of the European Space Agency (ESA) and NASA. The second and third missions were coordinated with the passage of the Ulysses spacecraft over the sun's south and north poles.

The sun's corona is difficult to study because its light is relatively dim

compared to the sun's total luminance. The white light corona can be viewed from Earth only during a solar eclipse, which strongly reduces the brightness of the scattered sunlight. Ground-based astronomers are never able to see the ultraviolet radiation because of interference from the Earth's atmosphere.

SPARTAN 201 is equipped with two complementary telescopes that can measure these emissions from the sun's corona. The white light coronagraph (WLC), provided by the High-Altitude Observatory in Boulder, Colo., will measure the density of the electrons in the coronal white light. The ultraviolet coronal spectrometer (UVCS) from the Smithsonian Astrophysical Observatory at Harvard will measure the velocities, temperatures, and densities of the coronal plasmas. The ultraviolet instrument and the WLC are housed in an evacuated cylinder with an aperture door that is opened after SPARTAN is released from the shuttle.

By comparing the data collected by the two telescopes and combining the observations of the SPARTAN 201 missions and Ulysses and observations made by ground-based instruments, scientists expect to gain a much more complete picture of the origin of the solar wind.

The WLC is an externally occulted coronagraph that will image the solar corona, providing measurements of the intensity and polarization of the electron-scattered white light. The SPARTAN WLC will also be used to cross-calibrate the SOHO satellite's UVCS white light channel and large-angle and spectrometric coronagraph.

The LISS located in the front of the WLC points the telescope at the sun's center. An external occulting disk at the front of the telescope blocks sunlight from the solar disk entering the WLC aperture with coronal light. The primary objective lens, located behind the external occulting disk, forms images of the corona and external occulting disk. The image of the occulting disk is blocked by an internal occulting disk behind the primary objective lens. The coronal image is then reimaged through a half-wave plate, which measures the intensity and polarization of coronal radiation, and a charge-coupled device (CCD) detector. Baffles between the telescope's aperture and the primary objective lens block direct sunlight from interfering with the coronal light, which is about  $10^{-9}$  times fainter than the light emitted from the solar disk.

The WLC also contains an optical path that allows in-flight calibrations of the intensity of the coronal light. This calibration path is aimed directly at the solar disk. Direct sunlight passes through mirrors, opal glass and a wheel with three different neutral-density filters and onto the CCD detector.

The UVCS measures the characteristics of ultraviolet light from atomic hydrogen and the brightness of light emitted by ionized oxygen in the sun's corona to determine the velocities of the coronal plasma blown away from the sun and the temperatures and densities of some of the major constituents of the corona and solar wind. The telescope's measurements are also used to identify regions where the solar wind originates and map



the sources of solar wind streams detected by Ulysses.

The UVCS will focus its observations on the north coronal hole, a region of exceptionally low density and temperature, and the areas between coronal holes and streamers, which are bright regions formed by particles trapped in the sun's magnetic field.

One of the major goals of the SPARTAN 201-05 mission is to continue tracking the changes in the morphology and physical conditions of the corona as it changes during the solar cycle. Missions 201-01, 02, and 03 were flown during the declining phase of solar activity. H I Lyman alpha profiles in coronal holes observed during the first three missions seemed to become less complex as the corona evolves toward solar minimum, when there are fewer high-latitude streamers intersecting the view of coronal holes.

The dominant light emission in the ultraviolet spectrum of the extended solar corona is called H I Lyman alpha. It is formed as Lyman alpha radiation from the chromospheric layer of the sun passes through the solar corona, where it is scattered by neutral hydrogen. The SPARTAN UVCS measures the variation of intensity with wavelength of H I Lyman alpha and the intensities of the light emitted and scattered by the oxygen ions at wavelengths of 103.2 and 103.7 nm.

In addition to verifying the profile shapes, the SPARTAN UVCS will provide a fresh radiometric calibration of the SOHO instrument. This is needed in order to distinguish changes in the observed intensities of the corona from changes in the efficiency of the SOHO UVCS. For this calibration, the SPARTAN instrument has been retrofitted with newly coated optics, and the entire optical paths of the Lyman alpha and O VI spectrometer channels have been accurately characterized. The planned joint observations of the corona by the two instruments will allow past and future SOHO UVCS observations to be compared with earlier SPARTAN observations. The data from both instruments will provide valuable information on how the corona changes throughout the solar cycle.

Measurements by the SOHO UVCS show that Lyman alpha profiles in polar coronal holes and coronal streamers are wider than those predicted by theoretical models. The broad Lyman alpha profiles correspond to hydrogen kinetic temperatures that are many times the temperature expected if the hydrogen atoms were in thermal equilibrium with the electrons in the corona. One explanation is that transverse waves in the corona are responsible for the hydrogen transverse velocities. Other evidence from the broad O VI profiles observed by the SOHO telescope suggest that there is strong heating of highly charged oxygen perpendicular to the coronal magnetic field. If this is also true for protons, the neutral hydrogen atoms would also be affected since they are coupled to the protons by charge transfer and collisions. Charged particles are believed to be accelerated by high-frequency magnetohydrodynamic waves that propagate through the corona much like a cyclotron accelerates charged particles.

The SOHO UVCS can look at spectral lines from ions of different masses and charge states to determine the basic properties of the waves that are accelerating these particles. Simultaneous observations by the SPARTAN and SOHO spectrometers will be used to confirm the profile shapes.

#### OBSERVING STRATEGY FOR UVCS

The UVCS has three slits for taking measurements. The smallest slit measures the profile of the H Lyman alpha spectral line. The largest measures the total intensity of the alpha line and a few nearby bright spectral lines at 124.2 nm. The O VI slit measures the total intensities of the O VI lines at 103.2 and 103.7 nm. Different regions of the corona can be observed by scanning the UVCS telescope mirrors to look at different heights and by rolling the SPARTAN 201 spacecraft to look at different position angles about the sun.

Observations are planned by looking at the latest images from ground-based and space-based telescopes just before the shuttle launch. Four primary coronal targets have been set in the SPARTAN UVCS flight software. The actual pointing of the spacecraft is not decided until a few hours before the SPARTAN 201 satellite is released from the shuttle.

The first target is a coronal streamer on the east (left) limb of the sun. Hydrogen Lyman alpha profiles and intensities will be measured at 1.7 and 2.1 solar radii on the streamer axis. Then the SPARTAN 201 spacecraft will roll about its sun-pointing axis to put the O VI slit on the axis of the streamer at the same heights.

The second target will also be a coronal streamer, but observations will be made at heliocentric distances out to 3.5 solar radii. Measurements of the H I Lyman alpha profile will be made along the streamer axis at 1.7, 2.1, 2.5, 3.0, and 3.5 solar radii. The Lyman alpha field of view at each height is positioned along the streamer axis by adjusting the spacecraft roll about its sun-pointing axis. For the measurements at 1.8 solar radii, the O VI field of view will be placed on the streamer axis.

These measurements will provide information on the kinetic velocities and bulk outflow velocities in closed magnetic field regions. The magnetic field configuration is expected to open up at the streamer edges and at the larger heights in the streamer. The plasma in these regions of open magnetic field may have different characteristics from the plasma in the closed regions.

The third target is above the sun's North Pole in a polar coronal hole. Observations will be made at seven heights near the axis of a coronal hole: 1.7, 1.8, 1.9, 2.1, 2.5, 3, and 3.5 solar radii. The last target is at a single height (1.7 solar radii) in the south polar coronal hole with the Lyman alpha detector only. (The O VI detector door is closed just before the last orbit in order to preserve the efficiency of the O VI photocathode.)

In addition to observing the solar corona, SPARTAN will take a look at the

solar disk on two orbits and record background/geocoronal measurements during nighttime portions of each orbit. The solar disk observations will be used to probe the Earth's exosphere in order to correct for its absorption and scattering effects on the spectral data. During a typical SPARTAN 201 orbit, the light from the sun goes through exospheric layers of different thicknesses. By following the variation of the disk light through an entire orbit, researchers can probe the effects of the exosphere. Since the SOHO satellite is outside the exosphere, comparing its observations with those of the SPARTAN UVCS will help researchers make necessary corrections in the SPARTAN Lyman alpha intensities and profiles and O VI intensities.

All of the coronal images and UV spectral data (line intensities and profiles) will be recorded on board the spacecraft for postflight analysis.

The SPARTAN 201 spectrometer is a more sensitive version of the instrument that was flown on rockets in 1979, 1980, and 1982. It consists of an occulted telescope, dual spectrometer, detectors for 1.216-angstrom radiation (atomic hydrogen) and 1,032- and 1,037-angstrom radiation (ionized oxygen), and electronics.

Because the SPARTAN UVCS instrument is retrieved by the shuttle, its in-flight performance can be inferred from preflight and postflight calibrations. Laboratory tests and experiments performed for the first three missions have provided detailed knowledge of the instrument's performance characteristics.

The rectangular SPARTAN 201 spacecraft consists of a service module that contains attitude control, thermal control, payload function control, and power distribution systems and an instrument carrier, a cylindrical container that holds the telescopes. On the bottom of the spacecraft is the upper portion of the release/engage mechanism, or REM. The lower half of the REM is attached to the spacecraft's payload bay support structure. The two halves of the REM mate to hold the spacecraft rigidly in place on the support structure and unlatch to allow SPARTAN to be deployed.

SPARTAN will be deployed from Discovery's cargo bay on flight day 2. A crew member will use the orbiter's 50-foot robot arm to lift the free-flying satellite from its support structure and release it in space. After SPARTAN is released, it must perform a 45-degree pirouette to confirm that it is functioning properly before its mission can begin.

SPARTAN will conduct its operations 70 to 100 miles from Discovery. Once the spacecraft is a safe distance from the orbiter, it will be activated by an internal timer and will initiate its preprogrammed mission. This program cannot be changed after SPARTAN has been deployed from the orbiter because there is no command or telemetry link between the two spacecraft. SPARTAN is completely autonomous while deployed: a battery supplies electrical power, and it has its own pointing system and a tape recorder for storing science data.

SPARTAN 201-05 will also carry three secondary experiments: SPAM,

TEXAS, and VGS.

The SPARTAN auxiliary mounting plate (SPAM) is a small equipment mounting plate that will provide a mounting location for small experiments or auxiliary equipment on the SPARTAN flight support structure (SFSS). A JSC-supplied accelerometer unit (WBSAAMD) will be flown on the SPAM.

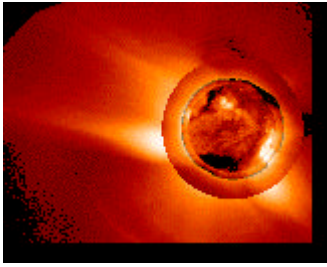
Technology experiment augmenting SPARTAN (TEXAS) is a Goddard Space Flight Center radio frequency communications experiment being baselined for advanced SPARTAN missions. The system will be used to allow real-time downlink of solar images and uplink of pointing corrections. The link for this mission will provide a fine pointing adjustment to the WLC based on solar images downlinked real time.

The video guidance sensor (VGS) flight experiment is a laser guidance system that will test a key component of the automated rendezvous and capture system (AR&C), a ranging and attitude measurement system being developed for the Reusable Launch Vehicle automated docking system. Until now, NASA missions involving spacecraft rendezvousing in orbit and one spacecraft capturing or connecting to another have relied on human control throughout those operations. The alternative is relying on an AR&C capability. System elements are being designed, developed, and tested by NASA to enable performing the task of spacecraft rendezvous and capture without having human operators at the controls. The AR&C technology under development at the Marshall Space Flight Center in Huntsville, Ala., requires little or no ground support. Onboard sensors, computers, and navigation inputs from satellites provide the intelligence to complete docking maneuvers through automated operations.

The system includes a video camera and dual-frequency lasers. A sensor will be mounted in the cargo bay of the space shuttle and an optical target on the SPARTAN spacecraft. The lasers will illuminate reflectors on SPARTAN--the VGSs target--and the reflected video images will define the exact position of the spacecraft and its distance from the space shuttle.

The laser-video system offers improved accuracy over the use of radio frequency control systems for docking maneuvers. In ground testing, the system has homed in on its target at pinpoint accuracy--down to one-tenth of an inch.

## **History/Background**



This is a reflight of the STS-87 SPARTAN 201-04, which developed problems shortly after being deployed from the shuttle in November 1987. After it was released, SPARTAN failed to perform a pirouette maneuver because of an incomplete initialization sequence. The spacecraft was sent into a spin when Columbia's robotic arm bumped it during a retrieval attempt.

After spacewalking astronauts recaptured the free flyer four days after its deployment, NASA was cautiously optimistic that SPARTAN could be deployed for a shortened mission. In the end, however, the mission had to be canceled because Columbia would not have had enough propellant for the rendezvous and capture activities.

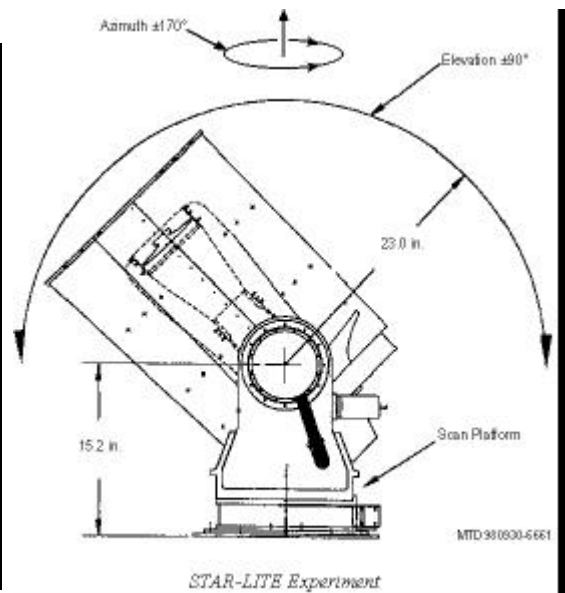
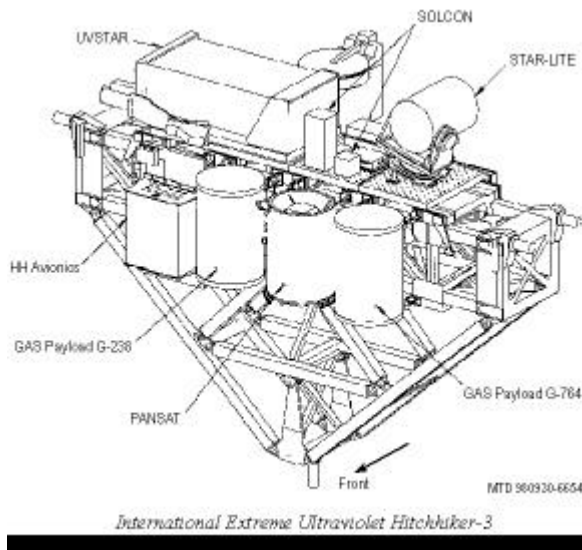
Postflight testing and reviews of data tapes at KSC in January confirmed that the SPARTAN satellite was healthy and had performed as expected. All flight data correlated well with in-flight predictions and assessments.

This is the fourth SPARTAN 201 mission. SPARTAN 201-01 flew on STS-56 in April 1993, 201-02 on STS-64 in September 1994, and 201-03 on STS-69 in September 1995.

The SPARTAN astrophysics experiments evolved from NASA's sounding-rocket science program. The SPARTAN project was conceived in the late 1970s to take advantage of the opportunity offered by the space shuttle to provide more observation time for the increasingly more sophisticated experiments than the five to 10 minutes allowed by sounding rocket flights. On this flight, for example, SPARTAN 201 will conduct observations of the sun for about 43 hours.

Externally occulted coronagraphs have been used on U.S. space missions since the technology was perfected in 1966 by Gordon Newkirk of the High-Altitude Observatory. The WLC is the third design produced by the High-Altitude Observatory and is 10 times more sensitive than the versions that were used on the Skylab mission in 1973-74 and the Solar Maximum Mission from 1980 to 1989.

The coronagraph was developed by French astronomer B. Lyot around 1932 to allow astronomers to study the sun's corona without having to wait for a total solar eclipse. The externally occulted coronagraph is an improved design that significantly reduces the scattered light generated by the telescope. The WLC also contains a polarimeter, which removes the effect of the light of the solar corona and the scattering in the cloud of dust, called the ecliptic cloud, left when the solar system was formed. A filter blocks the glow caused by atmospheric molecules colliding with the SPARTAN spacecraft.



## Benefits

Discoveries about the unknown source of the energy that heats the solar corona and accelerates the solar wind may help scientists understand the winds that carry mass and momentum away from other stars and why the sun's rotation has slowed. The results may also help them to explain how the Earth's magnetism and, ultimately, its climate and weather are affected by variations in the radiation and particles emitted by the sun.

The results will also benefit the designers of Earth-orbiting spacecraft. The torrent of electrons, protons, and ions streaming from the sun at speeds of almost 1 million miles per hour causes the spectacular Northern and Southern lights, but it also is responsible for degrading the performance and reliability of spacecraft in Earth orbit.

Updated: 10/08/1998

# STS-95

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## Experiments

### Protein Turnover Experiment In-Cabin

**Prime:** Scott Parazynski

**Backup:** Pedro Duque

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### Overview

Study of microgravity effects on the body's ability to maintain protein levels.

Updated: 10/08/1998

# STS-95

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## Experiments

### Clinical Trial of Melatonin as a Hypnotic for Space Crew (SLEEP-2) In-Cabin

**Prime:** Scott Parazynski

**Backup:** John Glenn

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### Overview

The "Sleep-2" experiment evaluates the normal sleep patterns for crew members to try to identify the causes for sleep disturbances known to occur during space flight.

Updated: 10/08/1998



# STS-95

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## Experiments

### Advanced Organic Separations

**Prime:** Scott Parazynski

**Backup:** John Glenn

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### Overview

An experiment designed to separate and purify biological materials for medical applications on Earth.

Updated: 10/08/1998

# STS-95

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## Experiments

### SPACEHAB Experiments

SpaceHab

**Prime:** Chiaki Mukai

**Backup:** Pedro Duque

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### Overview

#### SPACEHAB EXPERIMENT SUMMARIES

##### **Vestibular Function Experiment Unit (VFEU)**

The Vestibular Function Experiment Unit (VFEU) aboard STS-95 will feature two marine fish, called Toadfish, as experiment subjects. Housed in the VFEU, the fish will be electronically monitored to determine the effect of gravitational changes on the inner-ear, or otolithic, system. The freely moving fish will provide physiological signals of the otolith nerves through an implanted, specially designed multi-pore electrode.

Measurements of various responses will be made before, during, and after the flight. This research will provide important information about mechano-sensory mechanisms in the human vestibular system and may be applied to therapy for equilibrium disorder or Earth-bound motion sickness

The VFEU experiment is powered on when the Fish Packages (FP) are installed at approximately L-35 hours and will run continuously until the FP's are removed at approximately R+5 hours. Responses of both the primary afferents and central nervous system efferent fiber will be continuously collected by way of the Neural Data Acquisition System (NDAS). The collected data will be recorded on the Data Recorder (DR). Pertinent experiment facility data will be downlinked for observation by VFEU ground personnel.

VFEU has been flown on three previous shuttle missions: STS-47 (SL-J), STS-65 (IML-2), STS-90 (Neurolab)

##### **Biological Research in Canisters (BRIC)**

SPACEHAB's Biological Research in Canisters (BRIC) payload experiment is intended to provide researchers with flight opportunities for investigations

into the effects of spaceflight on plant specimens and to investigate the effects of electrical fields on plant roots.

The growth and development of higher plants are strongly influenced by gravity, and cell walls play an important part in supporting the plant body under terrestrial gravity conditions. Therefore, physical properties of the cell wall will change greatly in the microgravity environment of space.

In this experiment, seedlings of rice and arabidosis are cultivated in microgravity aboard the SPACEHAB module. The frozen cell wall samples returned from space will be analyzed for mechanical, enzymatic and structural changes.

The BRIC experiment consists of plant samples contained in petri dishes and support hardware. Crew will manipulate the samples on orbit and record plant growth with video and 35 mm cameras.

### **Oceaneering SPACEHAB Refrigerator Freezer (OSRF)**

The Oceaneering-SPACEHAB Refrigerator Freezer (OSRF), an advanced technology thermoelectric refrigerator freezer, is being flown for the first time on STS-95 in support of the BRIC and VFEU payloads.

The OSRF can be mounted as a double locker assembly in either the Orbiter middeck, replacing two standard stowage lockers, or in the SPACEHAB Module via a double experiment mounting plate. On STS-95, OSRF will operate in the SPACEHAB Module at 4.0 degrees C.

Capable of the supporting life sciences and other requirements aboard the Space Transportation System, OSRF offers a refrigerated payload volume of 1.85 ft<sup>3</sup> with minimal required maintenance. Each OSRF unit (including desiccant pack) weighs 80.27 pounds (without contents) and operates with continuous power of 70 Watts and 380 Watts peak.

STS-95 crewmembers will spend about 40 minutes total performing daily OSRF status checks.

### **Organic Crystal Growth Cell (OCC)**

The objective of the Organic Crystal Chamber (OCC) experiment is to investigate an anisotropic property of organic ferromagnet. Diffusing donor and acceptor materials into a reaction chamber containing the organic solvent will grow a large, high-quality, single crystal of organic ferromagnet. The intent is to obtain large, high-quality crystals of organic ferromagnet by diffusion methods from an organic donor and acceptor in an organic solvent under microgravity conditions.

Previous Flights of the OCC include re-flight of OCGP payload from STS-42

(IML-1). The experiment will consume one half-hour of crew time.

### **Advanced Gradient Heating Facility (AGHF)**

The AGHF experiment is a Bridgeman furnace designed for directional solidification and crystal growth, featuring the capability of demarcation of the solidification front by Peltier pulse marking and of thermal coupling of the experiment cartridge to the cooling zone by means of a liquid metal ring. Contained in a SPACEHAB Single Rack, the AGHF includes an Electronics Module (ELM), the Core Facility Module (CFM), the Core Access Panel and the Gas Storage Module.

The AGHF will not be powered during launch and landing. On-orbit, the crew will configure the furnace for operation, vent the facility and verify establishment of a vacuum and perform a trial run.

Nine processing runs will be performed. When a processing run is completed, the crew will configure the furnace, either for the next run or for landing, as required. Following a given processing run, the furnace is powered down; however, the electronics, the water cooling, and the air cooling are continuously running. Between experiment runs the furnace will be pressurized to cabin ambient, the processed cartridge removed and stowed, a fresh sample cartridge installed, and vacuum established in the furnace. If a delay greater than 60 minutes is scheduled between runs, the entire AGHF facility can be powered down after consultation with the AGHF ground control team.

### **Facility for Adsorption and Surface Tension (FAST)**

The Facility for Adsorption and Surface Tension (FAST), which will be housed in two SPACEHAB lockers, will be used to investigate surface phenomena at liquid-liquid and liquid-gas interfaces in microgravity to eliminate the effects of buoyancy- and gravity-driven convection. Principal scientific goals for FAST include: studies of the dynamic surface tension of water solution; dilation properties of surfaces by adsorption kinetic studies; and study of the interface between non-coalescing liquids.

The FAST hardware is not powered during the prelaunch/ascent phase of the mission. The experiment operations begin with the crew activating the FAST manual power switch. Once the crew switches on the power, the ground control team will send software commands to activate the science after the experiment reaches thermal equilibrium. The crew activities involve daily status checks of the FAST experiments; however, the operation and monitoring of the experiment will be controlled via ground commanding. After completion of all the experiment runs, the crew will shut off the experiment in preparation for the descent phase of the mission.

### **Advanced Protein Crystallization Facility (APCF)**

A veteran of four previous Shuttle missions, the APCF facility provides a cooled and heated volume that permits growth of protein crystals in microgravity. The units are locker-insert payloads and have flown on SPACEHAB and SpaceLab many times. The objective of the APCF experiment on STS-95 is to crystallize solution samples in orbital microgravity and to return them for post-flight analysis. On STS-95, SPACEHAB is providing both lockers. The units have very few crew controls and are largely automated. APCF will require about 30 minutes of crew time.

During mission operations, the two APCFs, with reactors and sample materials, are inserted into SPACEHAB lockers and powered prior to launch. Once on-orbit, the Experiment Start switch command will start processing which will progress automatically through the pre-process stages. Daily status checks will be carried out with LED status recorded on the FDF cue card. Near mission end, the Experiment Stop switch command will cause the facility to go into its post-processing stage, shutdown, but remained powered.

### **BIOBOX**

BIOBOX is an incubator/refrigerator that will house several groups of samples that relate to human bone & cell growth. Experiment operations and monitoring are performed from the POCC.

### **Self-Standing Drawer - Morphological Transition and Model Substances**

SSD/MOMO is a reflight experiment from STS-84 which will melt a low temperature solid sample and record the melt zone on video. Crew will activate, status check, and deactivate the hardware.

### **Osteoporosis Experiment in Orbit (OSTEO)**

The OSTEO experiment is designed for the in-vitro evaluation of bone cell activity under microgravity conditions. Crew will perform sample feeding and fixation operations, daily status checks and experiment deactivation.

### **National Institute of Health Cell Culture Module - (NIH-C8)**

The Cell Culture Module (CCM) is a hardware unit designed specifically to aid in the study of microgravity effects at the cellular level. It utilizes hollow fiber bioreactor cartridges as the basic cell support structure and allows controlled physiologic maintenance, manipulation, and testing of cellular

biology. Crew interaction involves in-flight activation, temperature recording twice per day, and deactivation.

### **Clinical Trial of Melatonin as Hypnotic for Space Crew (Sleep-2)**

The Sleep-2 experiment will evaluate the normal sleep patterns of crewmembers before, during, and after space flight in order to identify the factors that may be contributing to sleep disturbances that are known to occur during space flight. This experiment will also perform a preliminary evaluation of the effectiveness of the pineal hormone melatonin as a hypnotic during space flight. Crew activities include donning the sleep gear and manual testing of alertness during several flight days, as well as providing and processing urine samples.

### **Protein Turnover Experiment (PTO)**

The PTO experiment will study the effects of space flight on whole-body and skeletal muscle protein metabolism. Blood samples will be taken pre mission, on-orbit as well as post mission. Two 24-hour urine collections are also required.

### **Commercial Protein Crystal Growth (CPCG)**

CPCG will produce high quality protein crystals in microgravity. The crew will activate and deactivate the experiments.

### **Microgravity Glovebox (MGBX)**

MGBX is a facility that allows safe manipulation of samples and the performance of experiments within a contained environment. Once the crew has set up the facility, the CDOT, CGEL, and IFFD experiments will be performed using the glovebox.

### **Commercial ITA Biomedical Experiments (CIBX)**

The CIBX experiment consists of two Commercial Refrigerator Incubator Modules (CRIMs) capable of containing various apparatus for the study of fluid and solid mixing and diffusion. The crew will set up, activate, monitor, log data, photograph, deactivate and stow the hardware on orbit.

### **Commercial Generic Bioprocessing Apparatus (CGBA)**

CGBA is designed to store, mix, and process biological samples in a microgravity environment. Crew will perform daily status checks.

### **Enhanced Orbiter Refrigerator Freezer (EORF)**

The EORF refrigerator/freezer will be powered on orbit and will remain powered through landing for cold storage of samples taken during the mission. Crew will activate the EORF, set the temperature, and monitor status twice daily.

### **Astroculture (ASC-8)**

Astroculture is a facility which will support two experiments during the STS-95 mission. One experiment, sponsored by International Flavors and Fragrances, Inc., New York City, is partnering with NASA's Commercial Center for Space Automation and Robotics. This experiment will study how microgravity affects the production of plant oils important to many consumer products. The crew is required to initiate experiments, download data, and terminate experiments.

### **Advanced Organic Separations (ADSEP)**

The ADSEP hardware provides the capability to separate and purify biological materials in microgravity with minimum crew interaction. The crew will activate the hardware, exchange sample modules, and deactivate the hardware.

### **Protein Crystallization Apparatus for Microgravity (PCAM 1)**

PCAM is a crystal growth facility for the production of large, high-quality protein crystals. The crew is required for activation and deactivation.

### **Biotechnology Dynamics - A (BIODYN-A)**

BIODYN-A will perform experiments aimed at providing aid in organ transplantation, diseases of the elderly, and diabetics. The crew will activate the hardware, perform daily status checks, and deactivate the hardware.

### **AEROGEL**

The Aerogel experiment will study the effects of microgravity on the formation of ceramic materials. The crew will activate and deactivate the hardware.

### **Microencapsulation Electrostatic Processing System (MEPS)**

The MEPS experiment will form microcapsules containing medicines to be used in the treatment of various diseases. The crew will activate the hardware, exchange processing chambers as runs are completed, and deactivate the hardware.

### **NHK Camera**

The NHK Camera is a high definition camcorder that will be flown as a replacement for an Orbiter camcorder and to certify this hardware for future flights on the International Space Station. The crew will destow, adjust and setup the hardware, record as required, disassemble and stow the hardware.

Updated: 10/08/1998



# STS-95

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## DTO/DSO/RMEs

Space Integrated Global Positioning System/Inertial Navigation  
System Tests  
DTO 700-15

**Prime:** Steven Lindsey

**Principal Investigator:** Pamela Lupo, Mark  
Mangieri, Scott  
Murray, Moises  
Montez, Joe  
Thibodeau, Ray Nuss,  
and Tony Pham

**Backup:** Curtis Brown

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### Overview

The SIGI is intended to replace the shuttle onboard TACAN and, eventually, the HAINS Inertial Measurement Units. The SIGI DTO will mitigate the technical and schedule risks of applying this new technology to the shuttle navigation systems by evaluating the system's performance in space flight. The SIGI unit will be mounted in Avionics Bay 3B and will be commanded by the PGSC.

Updated: 10/07/1998

# STS-95

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## DTO/DSO/RMEs

### Space-to-Space Communications Flight Demonstration DTO 700-18

**Prime:** Stephen Robinson

**Principal Investigator:** Jeffery W. Williams

**Backup:** Pedro Duque

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#### Overview

The SSCS allows for direct communications between orbiting spacecraft in close proximity. This enables the Orbiter, the ISS and EVA astronauts to use the same system for communicating voice and data independent of ground support. The SSCS general command capability augments the S-band system and provides for enhanced safety and will replace the current EVA frequency comm bands.

The purpose of this Space-to-Space Communications System (SSCS) test is to demonstrate the systems capabilities and to allow the crew to gain familiarity with its operation during a mission.

Updated: 10/07/1998

# STS-95

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## DTO/DSO/RMEs

### Crosswind Landing Performance DTO 805

**Prime:** Curtis Brown  
**Backup:** Steven Lindsey

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#### Overview

The purpose is to demonstrate the capability to perform a manually controlled landing in the presence of a crosswind.

Updated: 10/08/1998

STS-95

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## **DTO/DSO/RMEs**

Automatic Targeting and Reflective Alignment Concept  
(AUTOTRAC) Computer Vision System (ACVS)

DTO 842

**Prime:** Stephen Robinson

**Principal Investigator:** Leo Monford

**Backup:** Scott Parazynski

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### **Overview**

The objective of the ACVS is to assess video quality of a new wireless camera system mounted on the Remote Manipulator System (robot arm).

Updated: 10/08/1998

# STS-95

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## DTO/DSO/RMEs

Space Station/Space Shuttle - Test of Color Printer

DTO 1215

In-Cabin

<b>Prime:</b>	Pedro Duque
<b>Backup:</b>	Stephen Robinson

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### Overview

This test will ensure that a candidate Inkjet printer (specifically, the Inkjet head and cartridge assemblies and the internal paper-handling mechanism) can operate in microgravity.

Updated: 10/07/1998

STS-95

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## **DTO/DSO/RMEs**

### **ORTHOSTATIC FUNCTION DURING ENTRY, LANDING AND EGRESS DSO 603C In-Cabin**

**Prime:** John Glenn

**Principal Investigator:** J. B. Charles, Ph.D.

**Backup:**

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#### **Overview**

This investigation will document the relationship between mission duration and changes in orthostatic function of crewmembers during the actual stresses of entry, landing, and egress from the seat and from the cabin.

These data will be used to determine whether precautions and countermeasures other than (or perhaps instead of) the operational saline countermeasure are needed to protect crewmembers in the event of an emergency egress.

Updated: 10/07/1998

STS-95

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## DTO/DSO/RMEs

### MAGNETIC RESONANCE IMAGING (MRI) AFTER EXPOSURE TO MICROGRAVITY

DSO 628

In-Cabin

**Prime:** Curtis Brown

**Principal Investigator:** Adrian D. LeBlanc,  
Ph.D./Baylor College  
of Medicine

**Backup:** Steven Lindsey

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#### Overview

This detailed test objective investigates the muscle, intervertebral disc, and bone marrow changes in several crewmembers of varying ages and compares the results to the current data base. As part of the investigation, the crewmembers will fill out a back pain questionnaire each day on orbit.

Updated: 10/07/1998

STS-95

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## DTO/DSO/RMEs

### IN-FLIGHT HOLTER MONITORING

DSO 630

SpaceHab

**Prime:** John Glenn

**Principal Investigator:** J. Yelle

**Backup:**

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#### Overview

This detailed test objective investigates whether heart rate exhibits less variability in microgravity than on Earth; if electrocardiographic (ECG) changes occur during flight; and if changes in ECG related to age occur during flight.

Updated: 10/07/1998



# STS-95

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## DTO/DSO/RMEs

### EDUCATIONAL ACTIVITIES

DSO 802

In-Cabin

**Prime:** John Glenn

**Principal Investigator:** Greg Vogt

**Backup:** Curtis Brown

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### Overview

The purpose of this activity is to use the attraction of space flight to capture the interest of students and motivate them toward careers in science, engineering, and mathematics. One 30 minute voice only session will be performed.

Updated: 10/07/1998

# STS-95

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## DTO/DSO/RMEs

### WIRELESS NETWORK CONNECTIVITY EXPERIMENT RME 1334

**Prime:** Pedro Duque  
**Backup:** Stephen Robinson

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#### Overview

Tests the operational and physical characteristics of a Radio Frequency (RF) based Local Area Network (LAN) in an environment similar to the International Space Station.

Hardware includes portable computers (equivalent to the Station Support Computer (SSC) with wireless Ethernet cards installed.

RME 1334 will only be performed if time becomes available.

Updated: 10/08/1998

# STS-95

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## DTO/DSO/RMEs

Orbiter Space Vision System Testing

DTO 700-11

Payload Bay

**Prime:** Stephen Robinson

**Principal Investigator:** I. J. Mills, S. G.  
MacLean, Ph. D., L.  
E. Hembree, T.  
Mulder, I. A. Christie

**Backup:** Scott Parazynski

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### Overview

The purpose of this Development Test Objective (DTO) is to evaluate the operation and performance of the operational vision unit, including new capabilities/operations in conjunction with the Orbiter Closed Circuit Television (CCTV) system in the on-orbit environment.

The OSVS is planned for operations early in the space station assembly sequence. The vision system will be the primary source of precision data with which the Shuttle RMS (SRMS) operator will perform station assembly operations that include Androgynous Peripheral Attachment System (APAS) and Common Berthing Mechanism (CBM) mating tasks.

The Spartan will be used to simulate assembly operations on STS-95.

### History/Background

Space Vision System (SVS) photogrammetry technology uses existing Shuttle payload bay camera views of targets on payloads and payload bay hardware to provide precise relative position, attitude, and rate cues in a concise graphical and digital format. The SVS will be used in support of initial space station assembly berthing tasks with the Shuttle Remote Manipulator System (RMS); it will also be used during later assembly tasks with the Space Station RMS. The SVS is also being assessed to determine its feasibility to provide range, bearing, and rate information associated with prox ops applications.

The SVS flew as part of Canex-II on STS-52. It provided the RMS operators with precision position and attitude cues to support Canadian Target Assembly (CTA) unberthing, maneuvering, and berthing operations. It was also used in support of CTA deployment and free-flying proximity operations.

The Advanced SVS (ASVS) was the next generation version of the SVS with significantly upgraded operational capabilities. Its hardware was based on a Personal Computer (IBM Thinkpad 755C) with a 4-bay expansion chassis containing video cards. The ASVS was flown as a DTO on STS-74, STS-80, and STS-85 to further evaluate on-orbit performance and capabilities of the vision system. SVS targets were installed on payloads of opportunity and the Orbiter to support this testing.

The Orbiter SVS (OSVS) is the operational version of the SVS for Shuttle applications; the Space Station application is known as the Artificial Vision Function (AVF). Both systems are hard-mounted in their respective vehicles. New capabilities of the OSVS and AVF include vision system control of cameras, more robust target degradation and target reacquisition, advanced photogrammetric algorithm processing, and a streamlined user interface. The OSVS will be flown on several test flights to verify vehicle integration, to evaluate on-orbit crew operations, and to characterize on-orbit system performance. On one flight, the CTA will be flown to allow characterization of the OSVS similar to that conducted on STS-52.

# STS-95

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## DTO/DSO/RMEs

### Single String Global Positioning System Tests DTO 700-14

**Prime:** Steven Lindsey

**Principal Investigator:** Ray Nuss, Wayne  
Hensley, Michael  
Sarafin

**Backup:** Curtis Brown

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#### Overview

The purpose of this experiment is to demonstrate the performance and operations of the GPS during Orbiter ascent, on-orbit operations, entry and landing phases utilizing a modified military GPS receiver processor and the existing Orbiter GPS antennas.

Updated: 10/07/1998

# STS-95

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## RENDEZVOUS

### SPARTAN 201-5 Rendezvous & Prox Ops

#### Overview

#### PROXIMITY OPERATIONS

SPARTAN rendezvous begins at payload release with Proximity Operations. Immediately following release of the target, the Orbiter will stationkeep (fly in formation) at a distance of 35 feet in an inertial attitude hold while SPARTAN attitude control is verified.

#### SEPARATION

Six minutes after release, the crew of Discovery will execute a separation maneuver (SEP1) at a rate of 1fps. The maneuver is designed to clear the Orbiter of the SPARTAN orbital path and to set up the second separation maneuver (SEP2).

SEP2 will initiate a retrograde separation to place Discovery ahead of the target on the same velocity vector. A phasing maneuver (NC1) will then set up the two spacecraft 5-6 miles apart - well within range of the Orbiters RF communication system. At this distance, SPARTAN controllers on the ground will command the spacecraft via the Orbiter Payload Interrogator for the start of TEXAS operations.

After 4 orbits of stationkeeping, a second phasing maneuver (NC2) will start Discovery on a slow separation to a distance of 30 nautical miles ahead of the SPARTAN, where NC3 will establish stationkeeping for several orbits of additional SPARTAN deployed science operations.

#### RENDEZVOUS

At completion of SPARTAN autonomous operations, a final phasing maneuver (NC4) will initiate a 2-orbit rendezvous profile placing Discovery behind and slightly below the target for the Terminal Phase of the rendezvous.

#### TERMINAL PHASE

Terminal Phase Initiation will begin at a distance of 8.2 nautical miles behind and below the target with a 9.4 fps OMS maneuver (Ti) which will set up Discovery for an "R-BAR" (underneath) final approach for the

capture of SPARTAN.

### **History/Background**

This particular rendezvous profile utilizes the "ORBT" approach - one which was developed for the Shuttle/Mir rendezvous and docking missions of the ISS Phase One Program. It is an "R-BAR" approach, which means the Orbiter approaches the rendezvous target from below and translates up the radial vector (imaginary line radiating from the center of the Earth to the orbiting target).

This particular "R-BAR" technique optimizes propellant usage over previous preferred techniques, and is the current choice in planning for missions to the International Space Station.

NOTE: More information about rendezvous maneuvers and terms can be found in the Shuttle Reference Data section.

Updated: 10/08/1998

# STS-95

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## Media Assistance

### NASA Television Transmission

NASA Television is available through the GE2 satellite system which is located on Transponder 9C, at 85 degrees west longitude, frequency 3880.0 MHz, audio 6.8 MHz.

The schedule for television transmissions from the orbiter and for mission briefings will be available during the mission at Kennedy Space Center, FL; Marshall Space Flight Center, Huntsville, AL; Dryden Flight Research Center, Edwards, CA; Johnson Space Center, Houston, TX; and NASA Headquarters, Washington, DC. The television schedule will be updated to reflect changes dictated by mission operations.

### Status Reports

Status reports on countdown and mission progress, on-orbit activities and landing operations will be produced by the appropriate NASA newscenter

### Briefings

A mission press briefing schedule will be issued before launch. During the mission, status briefings by a flight director or mission operations representative and when appropriate, representatives from the payload team, will occur at least once each day. The updated NASA television schedule will indicate when mission briefings are planned.

### Internet Information

Information is available through several sources on the Internet. The primary source for mission information is the NASA Shuttle Web, part of the World Wide Web. This site contains information on the crew and its mission and will be updated regularly with status reports, photos and video clips throughout the flight. The NASA Shuttle Web's address is:

<http://shuttle.nasa.gov>

If that address is busy or unavailable, Shuttle Information is available through the Office of Space Flight Home Page:

<http://www.hq.nasa.gov/osf/>

General information on NASA and its programs is available through the



NASA Home Page and the NASA Public Affairs Home Page:

<http://www.nasa.gov>

or

<http://www.nasa.gov/newsinfo/index.html>

Information on other current NASA activities is available through the Today@NASA page:

<http://www.nasa.gov/today.html>

The NASA TV schedule is available from the NTV Home Page:

<http://www.nasa.gov/ntv>

Status reports, TV schedules and other information also are available from the NASA headquarters FTP (File Transfer Protocol) server, [ftp.hq.nasa.gov](ftp://ftp.hq.nasa.gov). Log in as anonymous and go to the directory /pub/pao. Users should log on with the user name "anonymous" (no quotes), then enter their E-mail address as the password. Within the /pub/pao directory there will be a "readme.txt" file explaining the directory structure:

- \* Pre-launch status reports (KSC): [ftp.hq.nasa.gov/pub/pao/statrpt/ksc](ftp://ftp.hq.nasa.gov/pub/pao/statrpt/ksc)
- \* Mission status reports (KSC): [ftp.hq.nasa.gov/pub/pao/statrpt/jsc](ftp://ftp.hq.nasa.gov/pub/pao/statrpt/jsc)
- \* Daily TV Schedules: [ftp.hq.nasa.gov/pub/pao/statrpt/jsc/tvsked](ftp://ftp.hq.nasa.gov/pub/pao/statrpt/jsc/tvsked).

NASA Spacelink, a resource for educators, also provides mission information via the Internet. Spacelink may be accessed at the following address:

<http://spacelink.nasa.gov>

### **Access by Compuserve**

Users with Compuserve accounts can access NASA press releases by typing "GO NASA" (no quotes) and making a selection from the categories offered.

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## Media Contacts

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